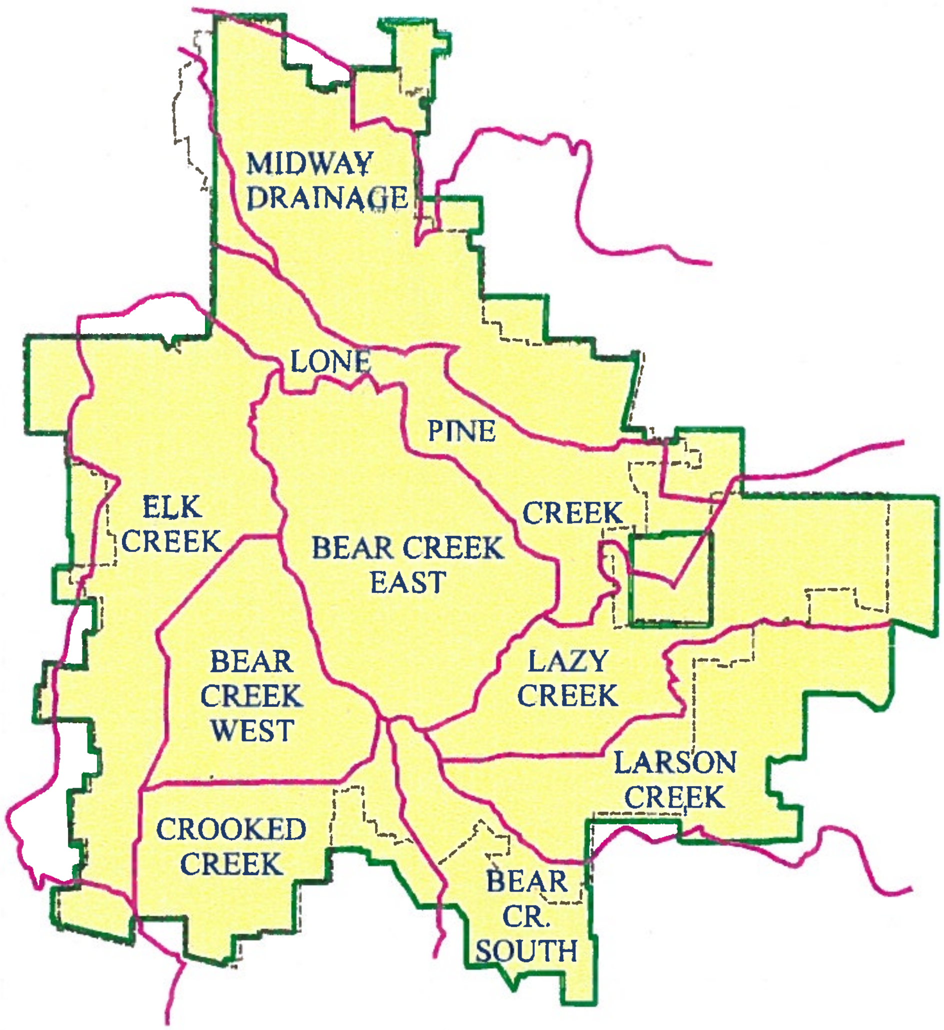
COMPREHENSIVE MEDFORD ARE DRAINAGE MASTER PLAN

VOLUME I



CITY OF MEDFORD
OREGON

September 1996

BROWN AND CALDWELL

COMPREHENSIVE MEDFORD AREA DRAINAGE MASTER PLAN

VOLUME I

CITY OF MEDFORD
OREGON

September 1996

REGISTERED PROFESSIONAL ENGINEER
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JAMES R. HANSEN
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September 20, 1996

Robert T. Deuel, P.E.
City of Medford
Public Works Department
Engineering Division
411 West Eighth Street
Medford, Oregon 97501

13-2119

Subject: Comprehensive Medford Area Drainage Master Plan

Dear Mr. Deuel:

We are pleased to submit the Comprehensive Medford Area Drainage Master Plan. The plan represents two years of dedicated work by City Public Works staff and our team members.

The plan is presented in two volumes: Volume I - Comprehensive Medford Area Drainage Master Plan and Volume II - Comprehensive Medford Area Drainage Master Plan, Technical Appendices. Volume I contains the recommendations of the planning effort and we envision that it will be used mostly by you and the public for implementation of drainage improvements. Volume II contains the approach used to develop, evaluate, and select the preferred alternatives.

We appreciate the opportunity to support the City of Medford in the development of this plan.

Very truly yours,

BROWN AND CALDWELL

Walter J. Meyer, P.E.
Principal in Charge

WJM:drf

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CHAPTER 1

EXECUTIVE SUMMARY

The *Comprehensive Medford Area Drainage Master Plan* (DMP) presents recommended capital improvements required to meet the future growth needs of the Medford urban area. The current City of Medford (City) drainage criteria, standards, and maintenance practices for stormwater management are discussed along with recommendations on how these tools can be used to improve the management of the storm drainage system. The impact of current and anticipated future regulations is presented, particularly in regard to water quality improvement and wetland protection objectives.

This document summarizes the overall master planning study. A separate document contains the DMP Technical Appendices which include discussion on the drainage area characteristics, hydrology and hydraulics, and the formulation and evaluation of alternatives to meeting future growth needs. Also included are four appendices addressing stormwater management issues: water quality in urban runoff; regulatory overview; stormwater criteria, standards, and policy; and an operations and management plan.

Plan Objectives

Objectives established for the update of the DMP include:

- Identify storm drainage improvements to satisfy existing system deficiencies and to meet future growth requirements within the study area.
- Develop an implementation plan that establishes a priority for construction of the required improvements.
- Recommend storm drainage management procedures to improve and protect water quality.
- Prepare a plan for reducing the impact of drainage improvements on wetlands and other wildlife habitats.
- Analyze storm drainage maintenance program and recommend changes to improve system efficiency and minimize operating costs.

Approach

The study area includes all of the area within the current Medford Urban Growth Boundary (UGB) and areas outside of the UGB that discharge stormwater runoff into the city conveyance system. Stormwater runoff flows from these areas were calculated using hydrologic models for the existing and the future full build-out conditions. The flows were determined for the major conveyance elements (e.g., pipes, culverts, open channels) within each of the nine drainage basins. The flows were generated using the City's existing design storm criteria which include the 10-year summer and winter storms and the 25-year summer and winter storms.

The modeled flows were compared with the allowable flows for each drainage element. Deficiencies were identified and alternatives to address the deficiencies were formulated. Proposed alternatives were tested using the hydrologic model. All proposed alternatives met the minimum requirement of eliminating the potential for flooding from the designated storms. Cost estimates were prepared for each of the alternatives. Appendix C, found in Volume II of this report gives a complete listing of conveyance elements and flows.

Costs were developed using May 1995 dollars based on an *Engineering-News Record* Construction Cost Index (*ENR* CCI) value of 5433. Projects were compared based on construction costs. The total cost of each project includes a 75 percent allowance for engineering, right-of-way acquisition, and contingency. Annual operations and maintenance costs were not included in the total project costs, but were considered in the alternatives evaluation process. Criteria were developed to evaluate the proposed alternatives. A joint city/consultant team selected a preferred alternative for each drainage basin based upon the criteria.

A priority ranking process was developed to establish a implementation schedule for the recommended capital improvements. The process identifies the projects that will provide the greatest benefit to the city. It is these projects that should be first implemented.

Recommendations

The type of alternative and total cost is shown in Table 1-1 for the recommended alternative for each drainage basin. Total cost for all recommended improvements throughout the city is approximately $35,130,000.

Table 1-1. Recommended Improvements

Drainage basin	Type of alternative	Estimated total cost, dollars
Midway	conveyance	2,732,000
Lone Pine Creek	12.5 acre-foot detention pond	2,605,000
Bear Creek East	conveyance	5,302,000
Lazy Creek	30 acre-foot detention pond	3,728,000
Larson Creek	conveyance	1,652,000
Crooked Creek/Bear Creek South	conveyance	2,196,000
Bear Creek West	diversion #2	6,207,000
Elk Creek	diversion	10,708,000
Total All Projects		35,130,000

Note: Cost includes construction, engineering, right-of-way, and contingency in 1995 dollars. (*ENR* CCI index 5433).

The individual projects which define the improvements to be made are identified in Chapter 4 for each drainage basin. Table 1-2 presents the results of the priority ranking process. The projects are listed in order of priority. The projects identified near the top of the table will provide the greatest overall benefit to the city. This table should be used as a guideline for developing each year's CIP plan. Details of all projects are found in Chapter 4.

Recommendations on stormwater drainage management procedures are presented in Chapter 3 and the appendices. These recommendations will help improve flood protection, water quality, and the overall efficiency of the maintenance program. The need to implement these procedures will increase as in stream water quality objectives for Bear Creek and the federal National Pollution Discharge Elimination System programs are more fully developed.

Under separate cover, the City of Medford Wetlands Mitigation Concept Plan presents an approach to protect and enhance wetlands within the UGB. The plan defines a strategy for wetland loss compensation to offset losses resulting from City construction projects. An active land acquisition plan and schedule are required to acquire key locations for future wetlands mitigation. Without such a plan, many potential sites may be permanently lost to development.

Table 1-2. Priority Ranking of Improvements

Project Name	Drainage Basin	Total Project Cost
Lazy Creek at Highland Drive	LZ	$141,610
Oak Street	BCW	$534,434
Peach Street	CC/BCS	$172,966
Other structural costs - pond	LZ	$2,000,000
North Fork	LA	$945,871
Earhart	BCW	$1,157,986
King Center Upgrade	MID	$1,629,564
Berrydale	ELK	$146,786
Lone Pine Central	LP	$650,114
Other structural costs - pond	LP	$438,000
Elk Miscellaneous	ELK	$971,607
Sunrise	BCE	$296,576
Howard Avenue	ELK	$597,753
Brookhurst	BCE	$962,013
Delta Waters Upgrade	MID	$424,581
Crooked near Stewart Avenue	CC/BCS	$182,490
Washington	BCW	$847,477
Connell Avenue	ELK	$1,802,162
Eagle Trace	LZ	$65,395
Lazy Creek at Murphy Road	LZ	$62,213
6th Street	BCW	$411,749
Lazy Creek at Crestbrook Road	LZ	$168,805
Lazy Creek at Burgundy	LZ	$204,208
North Phoenix	LZ	$385,253
Skycrest	LZ	$73,850
Lazy Creek at Siskyou Blvd.	LZ	$252,000
Oregon Avenue	BCE	$245,830
Larson Central	LA	$469,277
Lazy Creek at Ellendale Drive	LZ	$174,195
Middle Fork	LP	$316,639
Highway 99	ELK	$630,847
Lazy Creek at Oak Drive	LZ	$142,854
NW Medford	BCW	$644,183
Crooked near Dove Lane	CC/BCS	$201,984
EKMEDCO - diversion section	ELK	$2,000,000
Stowe Avenue	ELK	$2,589,592
Ehrman Way	ELK	$494,400
Blackoak	LA	$236,396

CHAPTER 2

INTRODUCTION

This updated *Comprehensive Medford Area Drainage Master Plan* (DMP) replaces the prior planning document completed in 1981. This previous document, the *Medford Area Drainage Master Plan,* (KCM, 1981) identified potential flooding problems associated with existing and future land use and growth projections for the subsequent 20 year period and recommended strategies to reduce flooding occurrences. Since 1981, Medford has undergone considerable growth and the Urban Growth Boundary (UGB) has been expanded since the preparation of the last plan. A new comprehensive storm drainage master plan was required to address this growth and to satisfy state planning requirements.

Authorization

In January 1995, the City of Medford (City) entered into an Agreement with Brown and Caldwell (BC) to update the existing drainage master plan. Woodward-Clyde was subcontracted to prepare technical memoranda on the local wetlands inventory, the wetland mitigation concept plan, and a summary of regulations governing stormwater. The updated DMP recommends storm drainage improvements to reduce the risk of flooding and improve water quality. The DMP focuses on a study area defined by the current UGB, although the study does include analyses of flows originating outside the UGB and entering into the study area.

Objectives and Guidelines

The objectives defined what was to be achieved by the planning study. Objectives established for the update of the DMP include:

- Identify storm drainage improvements to satisfy existing system deficiencies and to meet future growth requirements within the study area.
- Develop an implementation plan that establishes a priority for construction of the required improvements.
- Recommend storm drainage management procedures to improve and protect water quality.
- Prepare a plan for reducing the impact of drainage improvements on wetlands and other wildlife habitats.
- Analyze storm drain maintenance program and recommend changes to improve system efficiency and minimize operating costs.

The guidelines defined specific requirements for the DMP and constraints placed on the planning effort. Guidelines used in the development and layout of this DMP include:

- The DMP will include a section that describes drainage area characteristics affecting water quantity and quality issues, including: drainage area boundaries, topography, geology and soils, vegetation, climate, rainfall, population, land-use, and the existing conveyance system including: pipes, culverts, ditches, irrigation canals, and streams (Appendix A).

- Appendix B summarizes the approach used to perform the hydrologic modeling. The design storms used in the modeling are identified. A hand calculation approach is presented for use by developers and the city for pipe flow calculations on small drainage areas, typically, less than 100 acres.

- Drainage alternatives to reduce flooding will include: conveyance system improvements (replacement or parallel pipes, culverts, and open-channels), detention facilities, diversion systems, and combinations thereof (Appendix C).

- The DMP will include recommendations on improvements required to address current drainage problems and future full build-out conditions (Chapter 4 and Appendix C).

- The location and cost of recommended improvements will be included in the DMP (Chapter 4 and Appendix C).

- An implementation plan will be developed that lists in order of priority the recommended drainage improvements (Chapter 5).

Background

Prior stormwater facility planning for Medford includes the 1964 Drainage Master Plan (CH2M, 1964) and the 1981 Drainage Master Plan (KCM, 1981). Other activities or events influencing facility planning include inclusion of Hopkins Canal in 1966 to carry stormwater, separation of the combined sewer system in the 1960s and 1970s, and expansion of service areas and the UGB.

The 1964 study, performed by the consulting firm of CH_2M (now CH2M HILL) included only a portion of the current study area. The study focused on the drainage areas lying east of Bear Creek. The City generally followed the recommendations provided by the CH2M HILL plan up until the 1981 plan update.

Older areas of the city were originally served by a combined sewer collection system. The combined system conveyed sanitary wastes and stormwater to the water quality control facility during normal or low flow storm events. Excess stormwater and sanitary wastes overflowed into Bear Creek when storm events exceeded the capacity limits for either the conveyance system or the treatment facility.

During the 1960s and 1970s, new federal and state water quality regulations required elimination of these combined sewer overflows. The combined sewer system was separated into storm drainage and sanitary sewer systems; this primarily affected the Bear Creek West drainage basin. Analyses were conducted to determine an overall plan for improvements in this area of the city. The Bear Creek West collection system does not have the capacity to meet current design storm criteria.

The drainage plan was updated in 1981. The City has used the updated plan to guide new development and to correct many drainage problems. The plan included those areas within the 1981 UGB (shown in Figure 2-1). The City has generally agreed with the capital improvement recommendations provided by the plan, although the improvement prioritization schedule was not always followed. The actual schedule for implementing improvements was influenced in part by recommendations made by the Maintenance Division as to the location of recurring storm drainage problem areas.

Expansion of the UGB adds land to the city's storm drain service area. The new areas may be developed at higher densities than assumed prior to UGB expansion. The most recent expansion of the UGB occurred in the northeast, east, and southwest and areas of the city. Both the 1981 UGB and current UGB are shown in Figure 2-1.

The history and operation of the numerous irrigation canals within the study area influences the City's stormwater management efforts. Nine drainage basins have been identified within the UGB for the purposes of this plan. Of these, six drainage basins have at least one irrigation canal that disrupts the normal overland flow of stormwater runoff. A bond issue passed in 1966 authorized construction of a box culvert in the Bear Creek East drainage basin to connect Hopkins Canal directly to Bear Creek. This combined use of an irrigation canal for crop irrigation and storm drainage service has served the City and the irrigation districts well in most instances. Exceptions have occurred where the irrigation canals have worsened flooding situations by discharging runoff from one area of a drainage basin into another area not capable of conveying the flow. An example of this situation is the 1964 flooding of Crooked Creek which received overflows from Phoenix Canal. Generally, the problems occur during summer storms while the canals are conveying irrigation flow.

Nature and Scope

Most of the information used to characterize the drainage basins was provided by a variety of existing City documents and drawings. Information used for this effort included the 1981 Drainage Master Plan, work maps and computer files from the preparation of the 1981 plan, electronic and paper copies of City street and planning maps, State of Oregon wetland inventory maps, 1"=300' photogrammetric maps of the city, aerial photographs, United States Geological Survey (USGS) maps for areas outside of the city, and City as-built drawings for storm drain improvements made since 1981.

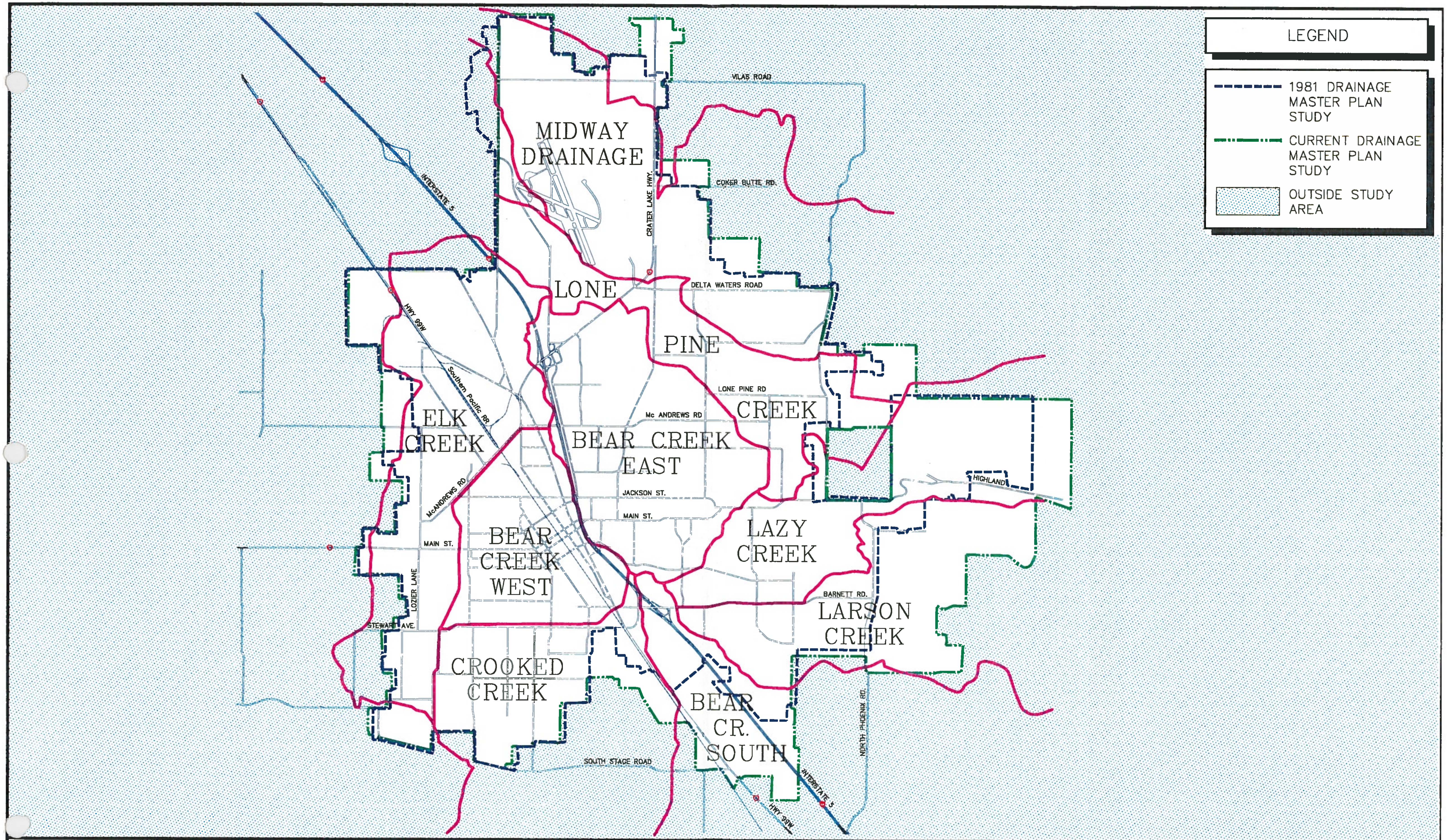
Additional facility information was provided by City personnel in selected areas where data was lacking or conflicting. Information on location and condition of wetlands and riparian areas was provided by consultant (Woodward-Clyde) field personnel during inventory efforts for the preparation of the Local Wetlands Inventory performed in conjunction with the master planning effort.

Rainfall records were provided by the U.S. Weather Service Office located at the Jackson County Airport. Other area rainfall records were available from the Southern Oregon Experimental Station at Hanley Station approximately 4 miles west of Medford and from the Medford Experimental Station located about 2 miles south of Medford. To show the wide range of precipitation volumes found spatially within the city, the Public Works Department had collected rainfall depths at approximately 40 locations during the September 28, 1994, event. Rainfall summary statistics were provided by the 1981 master plan and the Development Guide for Residential Subdivisions in the City of Medford (1977).

Hydrologic modeling was completed using the HYDRA storm and sanitary analysis software. HYDRA is a commercially available software system written by Pizer, Incorporated (Pizer, 1990). The hydrologic model was used to determine stormwater runoff flows at critical sections of the conveyance system within each basin for both the existing and future land use conditions. A spreadsheet model developed for this study compared the flows from the hydrologic model with the design capacities of the existing conveyance system. The spreadsheet recommended improvements where the existing system was determined to be deficient. All alternatives considered during this study were checked against the hydrologic and improvement selection models. A variety of improvements were considered including: replacement pipes/culverts, parallel pipes/culverts, detention, alternative routing or diversion, and various combinations of these improvements.

A recommended capital improvement plan is presented for each drainage basin. Each plan defines the nature and cost of improvements to be made in the respective drainage basins. Drainage system improvements are recommended on a project basis that is named for the area of the city in which the improvements occur. Each project may be defined by any number of pipe and channel improvements as defined by the project's study area. Details on the components of each project are identified in Chapter 4 and Appendix C.

A city-wide implementation plan establishes a priority for implementing storm drainage improvements. The implementation plan is based upon the recommendations of a joint city and consultant team project priority evaluation process. Criteria used in the evaluation included: flooding potential of the project area, flooding impact on project area, frequency of flooding problems, and the environmental/regulatory sensitivity of the project. The implementation plan is described in Chapter 5.



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North
No Scale

Drainage Master Plan

FIGURE 2-1
DRAINAGE STUDY AREA

CHAPTER 3

STORMWATER MANAGEMENT

Stormwater drainage master planning is a process by which existing and future deficiencies in the storm drainage system are identified, alternatives to meet the basin needs are evaluated and recommended, and preferred alternatives that best meet the overall objectives of the city are selected. Traditionally, the focus of this effort has been to identify the capital improvements (e.g., pipe, culverts, detention ponds, channels) required to reduce the risk of flooding.

Today, stormwater master planning encompasses a broader focus. Flood control is still the primary objective, but other objectives are now included in the planning process. Development of this plan incorporated the following elements:

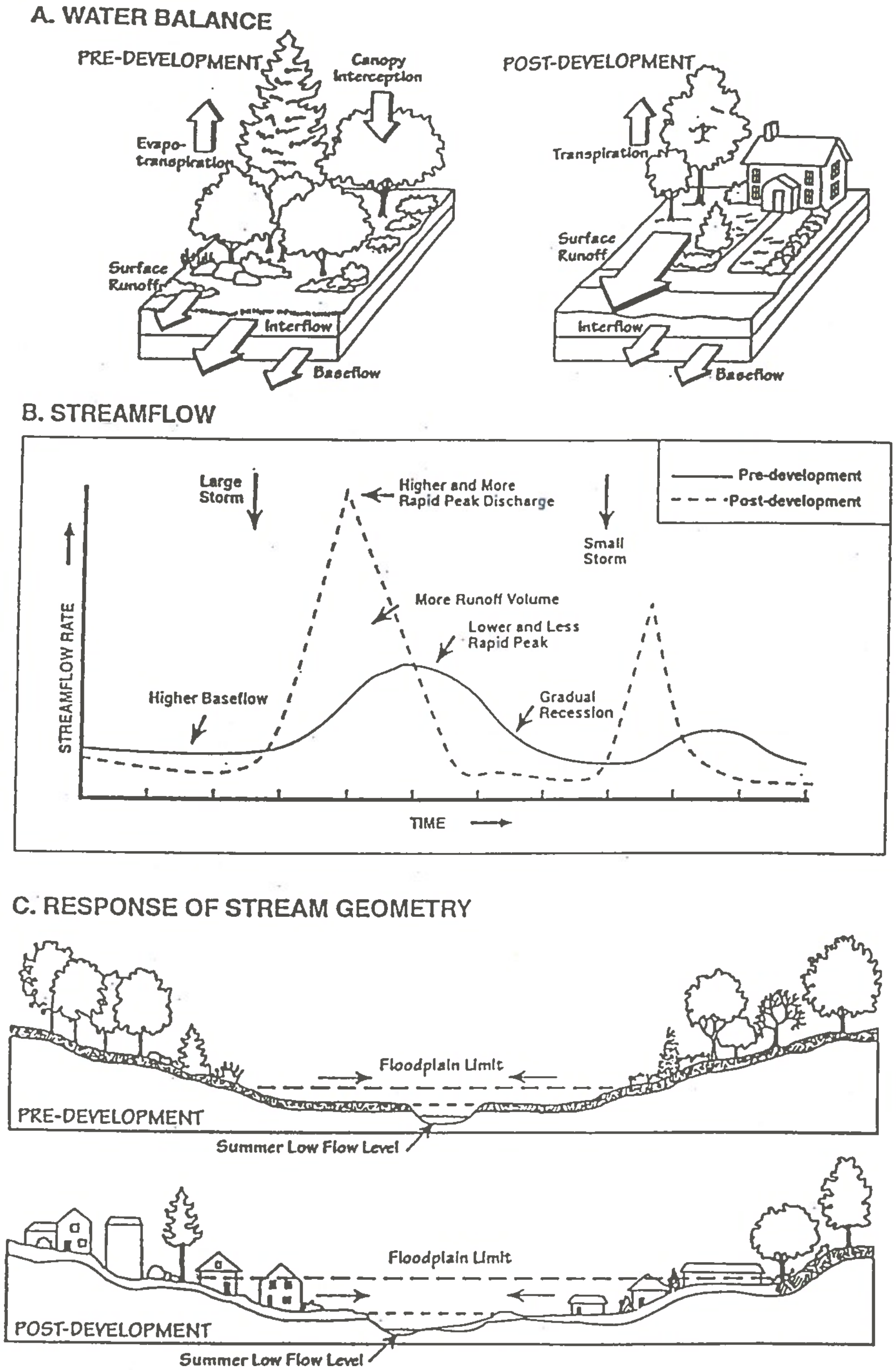
- urbanization effects on stormwater runoff
- regulatory impacts on stormwater management
- wetland protection and enhancement
- stormwater criteria, standards, and policy
- operations and maintenance

This chapter summarizes how these elements were incorporated into the plan. A more detailed description of each of these elements is provided in the stormwater management appendices or in the separately-bound Wetlands Mitigation Concept Plan.

URBANIZATION EFFECTS ON STORMWATER RUNOFF

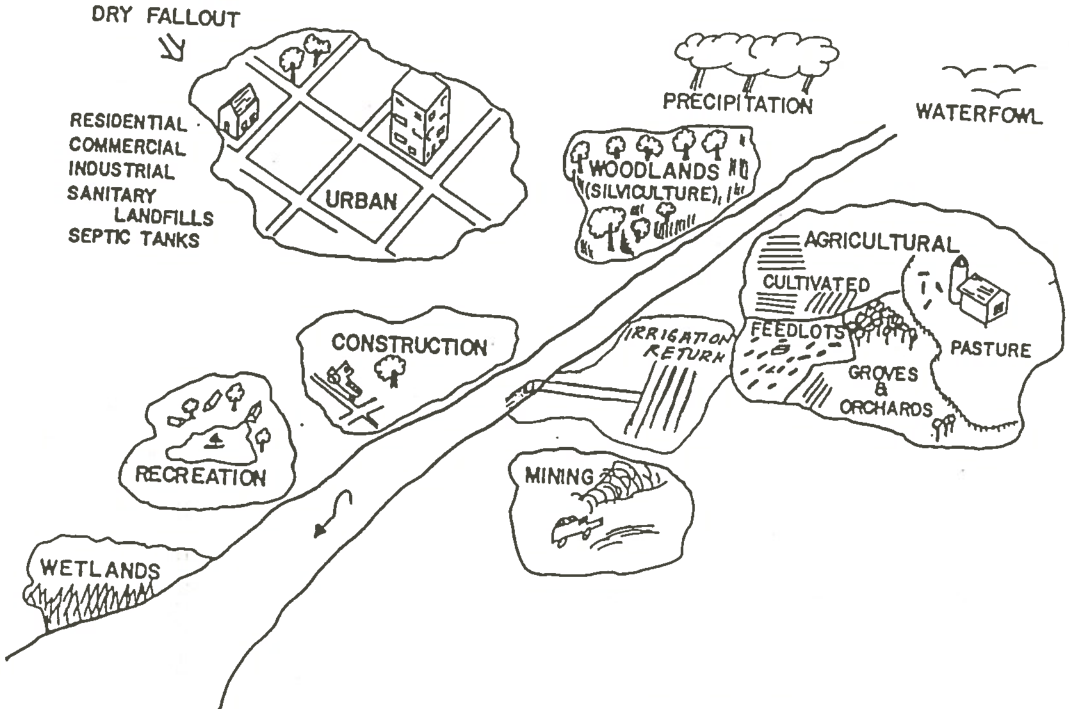
Urbanization is recognized as having a substantial impact on the nation's waters. When an area develops, the natural water balance is disrupted, as shown in Figure 3-1. There are fewer plants to intercept the rain and to transpire water into the air. Instead of soaking into the ground, water collects and runs off impervious surfaces. The volume and flow rate of stormwater runoff increase, causing runoff to reach receiving streams more quickly. In general, there is less recharge to groundwater to contribute base flow to streams and rivers. These factors cause changes in stream geometry, which in turn alter plant and animal habitats.

Urbanized areas also contribute much higher loads of pollutants to runoff than undeveloped areas. The largest sources of pollutants in urban areas are from vehicles and roadways. These and other types of non-point sources of stormwater pollution are shown in Figure 3-2. Typical pollutants found in urban runoff include metals, organic substances that demand oxygen during decomposition, and excessive quantities of phosphorus and nitrogen nutrients. High pollutant loads may degrade natural wildlife habitats and have negative effects on aquatic life.



Source: Washington Council of Governments

Figure 3-1. Effects of Urbanization on Stormwater Runoff



Source: M. Wanielista, Y. Yousef, 1993, *Stormwater Management*

Figure 3-2. Examples of Non-point Pollution Sources

The following pollutants are associated with stormwater:

- Sediment, including heavy metals such as lead, copper, zinc, and cadmium
- Nutrients such as nitrogen and phosphorus
- Human and animal bacteria and viruses
- Organic chemicals such as hydrocarbons and pesticides

Sources of these pollutants include:

- Automobiles
- Industrial discharges
- Construction and new development sites
- Application of pesticides, herbicides, and fertilizers
- Illegal discharges
- Atmospheric deposition of combustion products
- Leaf litter, grass clippings, and decaying plants
- Hazardous material spills
- Human and animal wastes

To reduce or prevent the negative impacts of urbanization, this drainage master plan recommends drainage basin improvements to reduce flooding and to improve the water quality characteristics of each drainage basin. Where recommended, the construction of detention facilities will reduce peak flow rates, thus limiting the erosive capabilities of high flows. The facilities should be designed, constructed, and maintained to provide multiple amenities, including: flood protection, water quality, and wildlife habitat enhancement. The city is encouraged to investigate stream protection and restoration activities in areas of high flow regimes or in areas where damage has occurred, respectively. The velocities calculated from the hydrologic modeling can be used to identify potential stream protection locations. Additional field work and analysis is required to further define candidate sites.

An increased number of water quality control facilities will be required in the future to address regulations focused on improving water quality and protecting natural habitat. Typically, these facilities require a greater maintenance effort than flood control facilities. Advanced planning for staff and equipment will be required to address the future maintenance requirements. Additional discussion on regulatory requirements and the maintenance program is provided in subsequent sections.

A Wetlands Mitigation Concept Plan has been developed to plan for offsetting any loss of wetlands that may occur due to future city development. This document is available under separate cover. Additional details of this plan are provided in a following section.

REGULATORY IMPACTS ON STORMWATER MANAGEMENT

Stormwater management includes construction of new facilities, repair or replacement of older, deficient facilities, and the maintenance of the existing system. Historically, the primary goal of the City of Medford's stormwater management activities has been flood prevention. Recent regulations have established other requirements that impact stormwater management. Specifically, these regulations require Medford to expand the focus of its stormwater management effort to include water quality improvement and natural resource protection.

A summary of the regulations that may affect stormwater management within Medford is presented in this section. A more detailed discussion is provided in Appendix E. Regulations affect the stormwater management in three key areas: water quality, natural resource protection, and flood control.

Water Quality

There are two key federal regulations regarding water quality that affect discharges into Bear Creek. The source of both of these regulations is the Water Pollution Control Act, also known as the Clean Water Act. The regulations include the National Pollutant Discharge Elimination System (NPDES) program and the water quality limited (WQL) status of Bear Creek. The NPDES program addresses the effects of urbanization on stormwater runoff through the municipal stormwater discharge permit program. Pursuant to Section 303 of the Clean Water Act, Bear Creek has been designated a WQL stream. As a designated WQL stream, Bear Creek has been assigned total maximum daily loads

(TMDLs) – the maximum amount of a pollutant that may be discharged into a stream without affecting water quality to a degree that limits beneficial uses.

The Environmental Protection Agency (EPA) is responsible for setting the guidelines for compliance with the Clean Water Act. In Oregon, the Department of Environmental Quality (DEQ) has the authority and responsibility for its implementation.

NPDES Program. EPA established the NPDES stormwater permit application requirements for municipalities serving populations of 100,000 or more. The agency has issued a guidance memorandum indicating there would be no immediate enforcement of such requirements for municipalities serving populations less than 100,000. This decision allows smaller municipalities a longer time table for meeting the NPDES requirements. As larger municipalities comply with the NPDES programs, EPA will have the resources to focus on the compliance activities of smaller sources.

The proposed NPDES requirements for smaller communities include prohibition of nonstormwater discharges and reduction of the discharge of pollutants to the maximum extent practicable. Permit applications may include stormwater monitoring and testing to identify types and concentrations of pollution. Other requirements focus on stormwater facility maintenance activities.

By anticipating the effects of future NPDES requirements, the City of Medford can start implementing maintenance procedures consistent with the policies and best management practices (BMPs) that will most likely be required. As these practices are put into effect over time, Medford's stormwater maintenance program will be in a position to provide water quantity and water quality benefits to Bear Creek and its tributaries.

TMDLs. A court decree issued in June 1987 directed DEQ to establish formal TMDLs on waters designated as water quality limited. DEQ is responsible for establishing beneficial use criteria for determining water quality pollution parameters.

TMDLs are allocated to the various pollutants that may be discharged to a stream. Waste Load Allocations (WLAs) are assigned to point sources by the DEQ to limit the quantity of pollutant discharged from individual point sources. At present, DEQ's focus has been the point source discharges that contribute the largest pollutant loads to Bear Creek. The largest source is the Ashland Sewage Treatment Plant. Ashland is addressing the problem of TMDL limits, and in a few years its contribution to Bear Creek water quality problems should be reduced.

In addition to point sources, non-point sources contribute significantly to the degradation of stream water quality. DEQ has identified the following as probable causes of the non-point source pollution:

- Surface erosion from agricultural lands, construction sites, and unpaved roads
- Storm runoff from paved roads and industrial/commercial sites
- Removal of riparian vegetation and loss of thermal cover over streams
- Placement of streambank structures and fills
- Water withdrawal

- Channel dredging/straightening
- Animal and human waste contamination
- Irrigation return flows
- Groundwater inflows

In 1993, the Oregon Environmental Quality Commission adopted an Oregon Administrative Rule which requires that non-point source program plans be developed by jurisdictions in the Bear Creek watershed. Plans must specifically describe how non-point source control activities will be managed in the watershed to comply with the established TMDLs. Designated management agencies, coordinated through the Rogue Valley Council of Governments (RVCOG), are responsible for establishing load allocations for non-point sources.

Stormwater Management Implications. The NPDES and TMDL programs will require much greater emphasis on water quality. The City will be required to take a more aggressive position on source controls and illegal discharges. Other impacts from the regulatory programs will affect the stormwater maintenance program.

The NPDES stormwater permit application requirements dictate that the effects of maintenance activities on water quality be evaluated. The evaluation is used to assess maintenance practices under the existing program and to identify new practices required to improve water quality. The most likely, direct impact to the maintenance program will be modifications to the procedures and frequencies for removing sediment from stormwater facilities and vegetation management practices. The regulations may require that additional BMPs be implemented to improve water quality, including street sweeping, improved spill response capabilities, erosion control, and streambank restoration.

Natural Resource Protection

Natural resource protection includes preservation of wetlands, ponds, riparian zones, and creeks. Wetland protection is the aim of both state and federal regulations that affect stormwater management, principally Sections 404 and 401 of the federal Clean Water Act and the Oregon Removal-Fill Permit Program (ORS 196.800-196.990).

A Wetlands Mitigation Concept Plan has been developed to address future wetland losses or degradation due to anticipated city development. The plan identifies a process by which wetland compensation would be provided. The plan identifies a priority listing of potential mitigation sites. The City should start proceedings to acquire these properties. Once acquired, wetland creation, restoration, or enhancement activities should be implemented to receive the desired wetland "credits." In this way, wetland compensation would not be piecemeal and the success of the projects would be greatly enhanced.

Clean Water Act. As defined in Section 404 of the Clean Water Act, wetlands are "those areas that are inundated or saturated with surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." Scientists use vegetation, soil, and hydrologic indicators to identify wetlands and to establish their boundaries.

For any construction within wetland areas, the U.S. Army Corps of Engineers (Corps) issues two categories of permits: individual and general. General permits are usually issued for classes of activities that have only minor impacts on wetlands. Approximately 40 types of general permits are available. Maintenance activities for existing facilities and construction of utilities can be covered under the general permit category.

Removal-Fill Law. The primary state regulation which is affecting development activities in and near wetlands is the Removal-Fill Permit Program, administered by the Division of State Lands (DSL). The Removal-Fill Permit Program regulates the removal of 50 cubic yards or more of material from one location in any calendar year, or the filling of a waterway with 50 cubic yards of material at one location at any time.

Stormwater Management Implications. Construction and maintenance activities are impacted by natural resource protection regulation. Sediment removal and vegetation management practices performed in upland areas having no wetland characteristics do not require a permit from the Corps. Sediment removal performed in areas that possess wetland characteristics require a permit.

Under the removal-fill laws, the DSL has no jurisdiction over wetland or waterway maintenance unless the volume of sediment removal exceeds 50 cubic yards. The DSL is primarily interested in retaining wetlands and replacing any wetlands lost to removal or fill operations.

Applications for wetland or waterway work received by the Corps or DSL are subject to review by several federal, state, and local agencies. Among the agencies that review the applications are the state and federal fish and wildlife services and the National Marine Fisheries Service. The Oregon Department of Fish and Wildlife (ODFW) reviews applications to determine if fish are known to inhabit the water body associated with the proposed work. The National Fish and Wildlife Service reviews applications to determine if there are endangered or threatened species issues associated with the proposed work.

If the proposed activities do not require a permit from the DSL and take place in a natural waterway, the ODFW should still be notified of the nature and location of the work. The ODFW will determine if the stream has fish value or if other wildlife issues are associated with the area of the proposed work. The ODFW will then make recommendations to the City on how to proceed with the proposed work while protecting the habitat. A common recommendation by ODFW is based upon in-water work timing standards that affect the time of year that sediment removal activities can be performed.

Implementation of the City's Wetland Mitigation Concept Plan will help ensure successful wetland mitigation within the City. The process will reduce the number of piecemeal mitigation sites and facilitate the permit application and review process with the governing agencies.

Flood Control

Flooding occurs when the flow in natural drainage channels exceeds the capacity of the channel, or it can occur locally when an inlet clogs or a culvert's capacity is reduced or blocked by sediment and debris. Other flooding problems may be the result of undersized facilities or irrigation practices. Facilities with insufficient capacity are addressed by the Comprehensive Medford Area Drainage Master Plan (DMP).

Flood Insurance. Economically affordable flood insurance is available to property owners through the National Flood Insurance Program (NFIP) authorized by the National Flood Insurance Act of 1968. The Federal Emergency Management Agency (FEMA) administers the program through the Federal Insurance Administration. Local involvement with the program requires that local communities establish floodplain management practices to reduce the amount of damage from future flood events. The City of Medford is participating in the flood insurance program and prohibits all construction in the floodway unless an engineering study can demonstrate the proposed construction would raise the 100-year flood elevation less than one foot.

The City also participates in the NFIP's Community Rating System (CRS) to receive credits on flood insurance premiums. The City currently receives the first level of rate reductions. Participation in the flood insurance program does not automatically place a city in the CRS.

The city's stormwater facility maintenance program must include the following major elements to receive credit under the CRS program. Routine inspection and maintenance are required for the major elements of the storm drainage system. CRS defines the drainage system as including open channels (ditches, concrete water courses, canals, natural streams, and wetlands), culverts, and bridges. The City may establish a size threshold that limits the number of facilities that must be maintained. CRS also requires that the City establish regulations that prohibit dumping into the drainage system.

Stormwater Management Implications. Routine inspection and maintenance of the drainage channels are an integral element of the CRS requirements. Inspections should be conducted based upon the actual needs of the system. Inspecting twice per year will earn full CRS credit. Minimum credit is provided for inspections on a once per five year schedule. Maintenance activities are scheduled based upon the need identified during the inspections. If debris and sediment accumulations are blocking flow, cleaning activities should be implemented.

CRS identifies the maintenance expectations for natural drainage ways. Generally, only trash and debris should be removed from natural channels. CRS encourages maintenance practices that will provide for better habitat and wildlife protection. A multiple objective approach for flood control, water quality, and natural resource protection is consistent with CRS guidelines.

Record keeping is required to document that inspection and maintenance activities are occurring as planned. Records of all inspections and maintenance should be kept on file and made available to a CRS inspector upon request.

STORMWATER CRITERIA, STANDARDS, AND POLICY

Each city establishes criteria, standards, and policies to help in the implementation of programs. The City of Medford's drainage standards were reviewed at an early phase of the stormwater master planning effort to determine their adequacy in supporting the stormwater management needs of the city. The results of this investigation are documented in Appendix F, Technical Memorandum 3.1--Review and Assess Existing Drainage Standards and Technical Memorandum 3.2--Recommended Drainage Standards. This section provides a summary of those findings.

The review and assessment of drainage standards focused in several key areas, including:

- Intensity-duration-frequency (IDF) curves
- On-site versus off-site detention/retention
- Infiltration systems
- Erosion control criterion
- Maintenance related criteria

IDF Curves

New IDF curves were developed based upon historical rainfall records. The new curves showed a marked decrease, up to 50 percent, in the rainfall intensity for storm events less than 1 hour in duration. The accuracy of the new curves was questioned due to the potential for the recent, dry period (approximately 10 years) experienced by the city to skew the curves such that the calculated runoff volumes could be underestimated. The City has decided to retain the original IDF curves. The original curves would provide consistency in design submittals and provide the city with a desired level of conservatism to accommodate future changes in the rainfall pattern, that is, a return to a wetter pattern. The curves are included as Figure B-1 in Appendix B.

On-Site Versus Off-Site Detention

It is recommended that the City continue with a combined on-site and off-site approach to stormwater detention/retention. Several regional detention facilities are recommended by this drainage study. These ponds provide flooding relief, and represent an economic savings over other proposed alternatives. Also, the ponds should be designed to provide other benefits such as improving water quality and providing additional wildlife and aquatic habitat opportunities.

In other drainage basins, the continued use of on-site detention is recommended. On-site facilities continue to be recommended in the Midway and Elk Creek drainage basins for commercial, industrial, and high-density residential development.

Infiltration Systems

Many areas of the northwest are able to use stormwater infiltration systems to dispose of stormwater. For example, the City of Portland is currently implementing a program to install thousands of infiltration and sedimentation manhole systems to relieve stormwater flows to their combined sewer collection system and for sewering areas of the city that did not previously have a storm drainage system.

The soils in the Medford area prevent the effective use of infiltration systems. The group B, C, and D Soil Conservation Service soil types represent moderate to very low infiltration rates, respectively. Infiltration systems can be used in areas of group B soils, but the use of infiltration systems should not be a requirement of the city.

Erosion Control Criteria

The City currently controls erosion through the building permit and inspection process. Prior to development, a subdivision grade plan depicting drainage conditions at the site must be submitted and approved by the City. The City can require additional erosion control protection for sites with high erosion potential. The City also relies on the NPDES stormwater permitting process implemented by the Oregon DEQ to control erosion from construction sites. The NPDES program requires stormwater permits and a Stormwater Pollution Control Plan from all construction sites of 5 acres or larger.

The City should consider developing comprehensive erosion control guidelines in the form of a manual to aid developers and City staff. The manual would identify specific objectives (criteria) to be achieved from the erosion procedures. Also, the manual would recommend specific erosion prevention controls applicable to the topography, soil types, and climate of the Medford area.

Erosion control requirements without proper enforcement are ineffective. Yet, inadequate site inspection and erosion control enforcement can be found at many municipalities throughout the county. City inspectors require training to understand the importance of erosion control and the practices required to prevent or abate erosion.

Many water quality problems found in urban areas are a result of inadequate erosion prevention. The City should adopt an aggressive erosion prevention position to anticipate some of the water quality requirements of future NPDES permitting and TMDL designation requirements.

Maintenance Related Criteria

The City has the authority and responsibility for maintaining city-owned stormwater facilities. The responsibility for maintaining privately owned facilities is not clearly defined in the city code. Yet the operation of privately owned facilities can directly affect flooding and water quality in downstream receiving waters. The current detention policy is to require on-site detention in the Midway and Elk Creek drainage basins. It is within these two basins that this maintenance responsibility issue is directed. The City should consider adopting an inspection program to determine if the privately owned facilities are being properly maintained. Enforcement authority would be required to ensure that the required maintenance was performed. Revisions to the city code are required to provide this authority.

Many municipalities have maintenance problems that are associated with not being able to access the storm drain facility. Even in areas where an easement or right-of-way is provided, it is often not adequate to get the proper equipment to the site. All new stormwater facilities for which the city has maintenance responsibility should be provided with adequate access. The maintenance department should be included in the submittal review process to ensure that access is provided for the types of equipment deemed necessary for the maintenance of the facilities.

Summary

The city's drainage criteria, standards, and policies greatly influence the implementation of the stormwater management program. The specific language to be adopted for inclusion of new criteria, standards, and policies is not provided by this document. Rather, it is the concepts that should be considered. The actual language of any city code additions or modifications should be developed with a complete understanding of the political and legal ramifications.

OPERATIONS AND MAINTENANCE

The City of Medford's storm drainage system is operated and maintained to provide a desired level of service to the community. To date, the primary emphasis of that effort has been to reduce the risk and consequences of flooding. Regulations and an increased awareness of the importance of maintaining the public's investment in the infrastructure have expanded the roles of operations and maintenance activities.

This section provides an overview of the operations and maintenance activities. The impact of these activities on system performance is described along with recommendations on how the level of performance of the drainage system could be improved.

Operations

The storm drainage system contains few controls that require adjustment or operation. The diversion structures located at the junction of many of the irrigation canals and natural streams represent the only facilities requiring operation. Currently, the operation of these controls is performed by the irrigation districts. The City has, or is developing, joint-use agreements that define operations and maintenance roles with the irrigation districts. The irrigation districts located within the Urban Growth Boundary, include:

- Medford Irrigation District—serves east and south Medford including Main Canal.

- Rogue River Valley Irrigation District—serves north Medford, which includes Hopkin's Canal.

- Talent Irrigation District—serves a small area in the extreme southern area of the city including the Phoenix Canal.

The controls are operated to provide irrigation flows to satisfy local agricultural needs during the summer and to discharge stormwater collected by the canals into existing streams during the winter. The existing control strategy works well most of the time, but has been known to contribute to flooding problems at other times. In 1964, flooding along Crooked Creek was worsened by overflow spilling in from the Phoenix Canal. This example and others occurred during brief, intense summer storms that produced runoff that was collected by the canals at a time of the year the canals were being used for irrigation. The flat slope and limited cross-sectional area of the canals are not adequate to convey irrigation flows and stormwater simultaneously.

The linkage between the irrigation and natural drainage systems poses a threat to the water quality of the receiving streams. Irrigation return flows that are allowed to discharge into the natural streams contain a number of the following pollutants: sediment, nutrients, pathogenic bacteria, and elevated water temperatures. These flows may enter the receiving streams at a time of year (summer) when flows are low and the dilution capacity of the receiving streams is limited. The risk to human health is compounded by the increased use of the streams for wading and swimming during the summer months.

Additional control structures are recommended by this DMP. Structures should be built at all junctions between the canals and natural drainage systems. These improvements would limit the distance that stormwater runoff would have to flow in the canals and thus reduce the potential for flooding. Operation of the controls would continue to be performed by the irrigation districts. Although, the construction and costs of the controls would be borne by the City. At several key locations, the City should consider automatic or remote telemetry systems to open valves during predetermined summer rainfall events of a specific intensity and duration.

Maintenance

The City's Storm Drainage Maintenance Division reduces the risk of flooding through the maintenance program. Sediment and vegetation management account for a majority of the maintenance effort. There are currently minimal water quality control structures in the stormwater facility inventory. As a result, water quality objectives have not been a high priority. The city has recognized the water quality impacts of certain maintenance activities (e.g., spraying, sediment removal) and has taken steps to limit these impacts.

If water quality control structures are needed in Medford in response to regulatory demands, the maintenance program will have to accept the maintenance responsibility of these facilities. The maintenance of water quality facilities will require staff training regarding facilities operation and the maintenance activities required to ensure efficient operation. Unfortunately, the maintenance of water quality facilities is not as intuitive as flood control facilities. Flooding will occur if trash racks, inlets, and channels are not properly maintained. The loss in performance of a water quality pond or vegetated swale is not readily observable. The City should plan now for training for the maintenance of these facilities.

The other direct consequences of constructing water quality facilities is that some of these facilities require specialized maintenance techniques and equipment, and more frequent maintenance. Future maintenance budgets should allow for the purchase of specialized equipment, additional personnel, and the training of staff.

CHAPTER 4

RECOMMENDED DRAINAGE BASIN PLANS

Hydrologic models were developed to characterize stormwater runoff and the conveyance systems within each of the nine major drainage basins. The models were used to analyze the system performance for both existing and future conditions. The City's design storms were modeled and system deficiencies noted; alternatives were then developed and modeled to alleviate these deficiencies. The results of the alternatives formulation and evaluation processes are presented in Appendix C.

This chapter presents the recommended alternative for each drainage basin. The recommended set of alternatives defines the drainage system improvements required to address deficiencies projected during future full build-out conditions. Improvements required to address drainage system requirements under current (1995) build-out conditions are provided in Appendix C. The cost estimates shown in the Appendix C worksheets will, in many cases, show a slightly higher total cost for an alternative than shown in this section. Conveyance elements with a 10 percent or less undercapacity are identified in the worksheets, but are not shown in this section. Flooding from these elements would be of very limited quantity, duration and frequency and do not warrant upgrading.

A summary table showing the recommended drainage system improvements is provided for each of the drainage basins. Each summary table identifies the major features of the recommended alternative. For ease of implementation, individual conveyance system improvements are grouped into specific projects. Each project is defined by a specific location within the drainage basin and the total cost of the improvements. A separate table is used to show elements of the existing drainage system not requiring upgrading. These tables are provided to show the physical characteristics of the existing system, e.g., diameter, length, slope, etc. A third table lists the channel label, length, modeled flow, and modeled velocity for open channel segments within each drainage basin. The drainage basin boundaries, the existing collection system (e.g., pipes, culverts, open channels, ponds, and streams), and the locations of recommended improvements are identified in the figure that accompanies each basin.

Most of the improvements recommended by this DMP will reduce the risk and the associated costs of flooding. Specific water quality facilities are not directly identified other than design of the detention ponds to perform a dual role: flood protection and water quality treatment. However, a number of water quality treatment opportunities exist. Sedimentation facilities, vegetated swales, sand and compost filters, treatment wetlands, etc., can be added to the storm drainage system to improve water quality. Recently, streambank restoration projects have been identified as having a significant water quality benefit. The City should start considering these types of facilities to meet future water quality objectives.

The construction costs are based upon the *Engineering News Record* Construction Cost Index (*ENR CCI*) of 5433 projected for May 1995. The total costs include engineering, right-of-way, and a contingency. Together, these additional costs represent 75 percent of the construction cost. Cost of land for detention facilities was estimated at $60,000 per acre for all drainage basins except Bear Creek East where land costs were assumed at $120,000 per acre.

The following eight subsections summarize the recommended drainage basin plans for the nine drainage basins.

Midway

The Midway drainage basin is located at the north end of the Medford study area with a large portion of the east side of the basin lying outside of the Urban Growth Boundary (UGB). The basin covers over 3400 acres, including the Medford-Jackson County Airport. It is a relatively flat basin with elevations ranging from 1700 feet in the east near the East Main Canal, to 1250 feet at its downstream end. The weighted average slope of the modeled conveyance system is less than 0.009 ft/ft.

Drainage from Midway does not directly enter Bear Creek like most of the other basins within the study area. Rather, flows from Midway move downstream through portions of the county prior to discharge into Bear Creek. Discharges from the basin will increase as a result of urbanization within the basin. Increased discharges from the basin could negatively impact downstream locations within the county. Coordination between the City of Medford and Jackson County is required to prevent problems from occurring in these downstream areas.

The flat slope of the lower end of the drainage basin results in poor drainage, resulting, in many wetlands, which were identified in the basin during preparation of the Local Wetlands Inventory. Wetlands are located along the main water courses and at numerous isolated locations throughout the basin. Most of the storm drainage improvements in the basin will not directly impact the existing wetlands. However, modifications to the storm drainage system have the potential to reduce base flows to the wetlands.

Zoning for the basin is 54 percent residential and 43 percent industrial. A small area is zoned commercial. Build-out in the residential areas will occur as the upper elevations near Coker Butte and the hills in the northeast section of the basin are developed. Other development opportunities exist in the area to the immediate north and northeast of the airport, although mostly industrial. Currently, only about 41 percent of the basin has been fully developed. Alternative 1, the conveyance solution, is the recommended alternative for the Midway Basin. The recommended alternative is shown as Figure 4-1.

RECOMMENDED ALTERNATIVE	
Alternative 1, Conveyance	**$2,732,000**

Under future build-out conditions, almost all of the main stem below Delta Waters is undersized. The conveyance system along many of the tributaries requires upgrading. No other alternatives were considered feasible for the Midway drainage basin. The relatively high water table reduces the effectiveness of detention ponds by limiting the available storage. The flat slopes throughout the watershed preclude the use of diversion as an alternative.

Since 1981, the City has required the use of on-site runoff detention for all industrial and commercial development within the basin. On-site detention is provided to limit the peak runoff rates during thedesign storms to 0.25 cubic feet per second per acre of new or redevelopment. This requirement should be continued. The flat slope of the basin limits the effectiveness of the conveyance system.

The existing on-site detention policy and the implementation of the recommended alternative will help ensure that flooding in the basin in minimized.

The system upgrades for the recommended alternative have been grouped into four projects, based on upgrade location and cost (Table 4-1.1). The four projects are the King Center Upgrade, the Delta Waters-Springbrook Upgrade, the Midway Upgrade, and the Delta Waters Upgrade. The costs for the projects range from $326,000 to $1.6 million.

Physical information on the elements of the drainage system not requiring improvement are shown in Table 4-1.2. The design flows for the open channel segments of the drainage system are shown in Table 4-1.3.

Drainage Basin: **Midway**

Table 4-1.1 **Recommended Alternative:** **conveyance**

Element (Tag)	Pipe Length (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Excess Flow (cfs)	Selected Arrangement	Selected Convey	Selected Pipe Diameter (in) or Height (ft)	If Box Culvert Additional Width (ft)	Total Element Cost	Total Project Cost
King Center Upgrade													
MD1A10A	450	0.002		8X4	187	645	458	3	pipe	72		$541,841	
MD1A11	54	0.009	60		159	323	164		box		10	$71,442	
MD1A11A	54	0.009	60		159	323	164		box		10	$71,442	
MD1A12	500	0.008		8X4	392	645	253	2	pipe	48		$212,828	
MD1A13	600	0.003		8X4	243	531	288		pipe		5	$513,450	
MD1A14	428	0.003	84		346	531	185	1	pipe	72		$185,850	
MD1A15	60	0.005	60		158	266	108	par	culvert	54		$14,192	
MD1A15A	60	0.005	60		158	266	108	par	culvert	54		$18,520	$1,629,564
Delta Waters-Springbrook Upgrade													
MD1A20	900	0.008	66		309	362	53	1	pipe	36		$178,374	
MD1A20A	525	0.007	66		281	292	11	1	pipe	21		$63,411	
MD1A22A	53	0.028	36		45	110	65		box		4	$37,100	
MD1A22	53	0.028	36		45	110	65		box		4	$37,100	
MD1F2	345	0.002	21		8	9	1	rep	pipe	24		$35,345	$351,330
Midway Upgrade													
MD1A29	700	0.019	30		57	121	64	2	pipe	27		$157,471	
MD1A30	1500	0.024	30		64	106	42	1	pipe	27		$168,719	$326,191
Delta Waters Upgrade													
MD1G1	926	0.024	24		35	48	13	rep	pipe	27		$104,156	
MD1G2	1850	0.018	24		30	41	11	rep	pipe	27		$208,087	
MD1G3	700	0.032	18		19	33	14	rep	pipe	24		$71,714	
MD1G4	450	0.021	18		15	22	7	rep	pipe	21		$40,623	$424,581
Other structural costs													
										Drainage Basin Total =			$2,731,666

Selected Arrangement Codes: box = box culvert, par = parallel culvert, rep = replacement, 1 or 2 or 3 = number of parallel pipes

Date: 09/13/96 J:\2119\COSTEST\SUMMARY\MIDSUM.WB1

Table 4.1.2 -- Non-CIP Segments

Midway Drainage

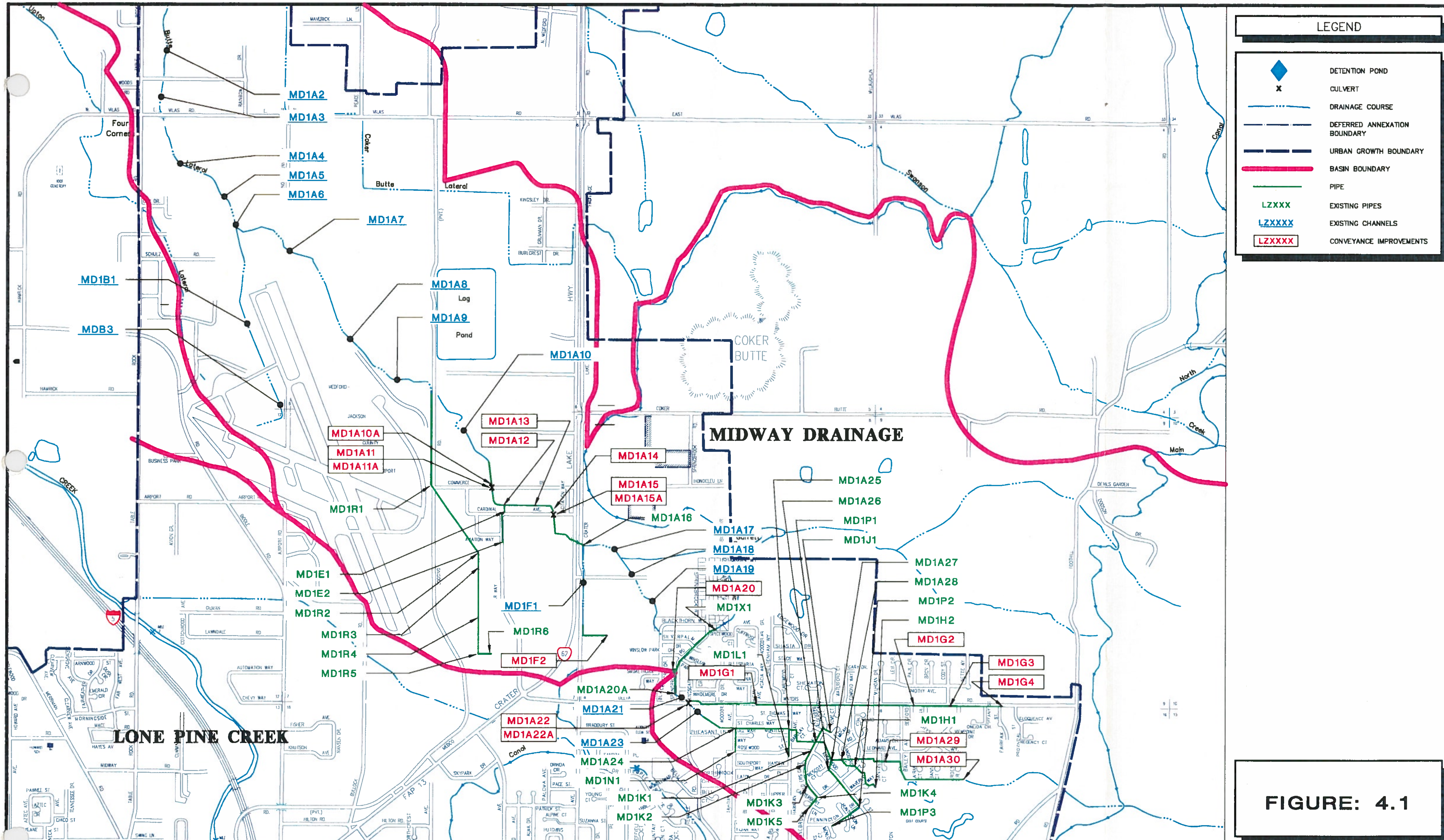
Future Condition – Conveyance

Date: September 96

Element (Tag)	Pipe Length (feet)	Pipe (P) Culvert (C) or Other (O) ?	Depth to Invert (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Percent of Capacity
MD1A16	800	P	7	0.008	84		570	509	89%
MD1A20A	525	P	5	0.007	66		281	292	104%
MD1A24	950	P	5	0.009	60		243	202	83%
MD1A25	1000	P	5	0.010	60		258	147	57%
MD1A26	700	P	5	0.008	60		231	144	62%
MD1A27	550	P	5	0.013	60		293	137	47%
MD1A28	155	P	5	0.005	60		191	129	68%
MD1E1	210	P	5	0.003	30		22	11	50%
MD1E2	560	P	5	0.003	24		12	11	92%
MD1H1	245	P	5	0.011	36		69	9	13%
MD1H2	540	P	4.5	0.018	30		55	9	16%
MD1J1	455	P	1.5	0.009	18		10	2	20%
MD1K1	235	P	3.75	0.015	21		19	5	26%
MD1K2	238	P	3.5	0.017	18		14	5	36%
MD1K3	337	P	3.25	0.023	15		10	5	50%
MD1K4	410	P	3.5	0.017	18		14	5	36%
MD1K5	200	P	3.75	0.004	21		10	5	50%
MD1L1	495	P	3.75	0.006	21		13	2	15%
MD1N1	415	P	3.5	0.010	18		11	9	82%
MD1P1	160	P	5	0.013	36		76	8	11%
MD1P2	850	P	4.5	0.027	30		68	8	12%
MD1P3	645	P	3.5	0.020	18		15	8	53%
MD1R1	1800	P	5	0.004		8X4	296	103	35%
MD1R2	1100	P	5	0.005	60		193	43	22%
MD1R3	610	P	4	0.005	48		78	25	32%
MD1R4	300	P	3.5	0.002	42		52	16	31%
MD1R5	300	P	3	0.002	36		18	5	28%
MD1R6	300	P	3	0.002	36		12	2	17%
MD1X1	735	P	5	0.001	54		59	55	89%

Table 4-1.3 Midway
Open Channel Flows

Element (Tag)	Channel Length	Slope	Controlling Storm	Modeled Flows (cfs)
MD1A1	680	0.0059	25sz	1201
MD1A10	1050	0.0076	25sz	698
MD1A17	600	0.0017	25sz	474
MD1A18	600	0.0067	25sz	442
MD1A19	1200	0.0092	25sz	362
MD1A2	1200	0.0083	25sz	1201
MD1A23	170	0.0032	25sz	220
MD1A3	630	0.0159	25sz	1201
MD1A3A	20	0	25sz	1176
MD1A4	1050	0.0019	25sz	1176
MD1A5	800	0.0025	25sz	1164
MD1A6	1000	0.002	25sz	1125
MD1A7	2000	0.002	25sz	1027
MD1A8	1600	0.0069	25sz	908
MD1A9	1170	0.0009	25sz	811
MD1B1	3300	0.0036	10sz	55
MD1B2	100	-0.002	10sz	55
MD1B3	1400	-0.0013	10sz	36
MD1F1	1600	0.0078	10sz	24
MD1A22	53	0.0275	25sz	220



BROWN AND CALDWELL
Portland, Oregon
(503) 244-7005

CITY OF MEDFORD

North
0 800 1600
Scale in Feet

Drainage Master Plan

MIDWAY DRAINAGE
FUTURE CONDITION - CONVEYANCE

Lone Pine

The Lone Pine basin is a long, narrow basin that covers slightly more than 2000 acres in the eastern part of the Medford drainage study area. The highest elevation is north of Lone Pine Road and east of Foothill Road at 2000 feet. The basin's lowest elevation is 1275 feet where Lone Pine Creek flows into Bear Creek. Slopes along the main channel are generally steeper in the upper reaches of the basin above Springbrook Road, although considerable variation exists along the entire channel length.

Hopkins Canal intersects the Lone Pine basin just to the east of Crater Lake Highway. East Main Canal crosses through the drainage basin at the east end of the basin. The presence of the canals increases the complexity of stormwater drainage within the basin.

Wetlands identified during the preparation of Local Wetland Inventory are located primarily along the existing water courses. Many of these linear wetlands are located in areas of the basin that have been developed. Others are located in the eastern areas of the basin where future residential development will occur. Erosion control practices will be required to prevent siltation in the existing wetlands from future development.

Nearly 75 percent of the Lone Pine Creek basin is zoned residential. Approximately 20 percent of the area is zoned industrial which is represented by the area located near the airport. Approximately, 50 percent of the basin has been fully developed. The eastern areas of the basin have opportunities for additional residential development. Additional industrial development is available in the area to the southwest of the airport. Alternative 2, the 12.5 acre-foot detention pond, is the recommended alternative. The recommended alternative is shown as Figure 4-2.

Constructing a 12.5 acre-foot detention pond near the LP2A22 segment between Brookdale Avenue and Lone Pine Road would decrease flows in this area by approximately 200 cubic feet per second (cfs), although the major benefits derived from the pond are on downstream sections of the stream. Those benefits are realized downstream of LP2A14 where the reduction in the peak flow is less (127 cfs reduction) due to tributaries entering the system below the pond. Regardless, the cost of improvements along the main stem of the creek is significantly reduced by the construction of the pond.

RECOMMENDED ALTERNATIVE	
Alternative 2, 12.5 acre-foot detention pond	**$2,605,000**

Siting a larger pond a little lower in the system (approximately one-third point from headwaters) would probably have a larger beneficial effect; however, there are limited opportunities for siting a large pond at this location.

The pond can be constructed to provide water quality treatment and offer aesthetic amenities to the community. The pond improves the reliability and flexibility of stormwater management within the basin.

The pipe upgrades for the recommended alternative have been grouped into five projects, based on upgrade location (Table 4-2.1). The five projects are the Middle Fork, the North Fork, the South Fork, Lone Pine Central, and Airport Road. The costs for the projects range from $107,000 to $650,000. The 12.5 acre-feet detention pond is estimated to cost $438,000.

Physical information on the elements of the drainage system not requiring improvement are shown in Table 4-2.2. The design flows for the open channel segments of the drainage system are shown in Table 4-2.3.

Drainage Basin: Lone Pine Creek
Table 4-2.1 Recommended Alternative: 12.5 ac-ft detention

Element (Tag)	Pipe Length (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Excess Flow (cfs)	Selected Arrange-ment	Selected Convey	Selected Pipe Diameter (in) or Height (ft)	If Box Culvert Added Width (ft)	Total Element Cost	Total Project Cost
Middle Fork													
LP1P2	1377	0.012	30		46	66	20	rep	pipe	36		$197,455	
LP1N1	280	0.004	48		96	260	164	2	pipe	48		$119,184	$316,639
North Fork													
LP1N7	1121.5	0.031	36		117	132	15	1	pipe	18		$94,026	
LP1N9	130	0.039	18		8	12	4	rep	culvert	24		$13,318	
LP1N3	600	0.014	N/A		0	260	260	new	pipe	60		$63,000	
LP1N2	923	0.014	42		119	260	141	2	pipe	36		$327,966	
LP1R2	512	0.008	18		10	12	2	rep	pipe	21		$46,220	$544,532
South Fork													
LP1L12	40	0.020	18		8	17	9	rep	culvert	27		$4,499	
LP1L1	718	0.004	30		26	35	9	rep	pipe	36		$102,958	$107,457
Lone Pine Central													
LP2A15	77	0.006		7X3.5	140	166	26		box		2	$44,872	
LP2A14	65	0.010		48	91	166	75	par	pipe	48		$10,641	
LP2A12	65	0.000		6x4	147	400	253		box		11	$85,995	
LP2A10	143	0.015	78		307	400	93	par	culvert	48		$33,622	
LP2A9A	511	0.006	48		110	218	108	1	pipe	48		$108,755	
LP2A7	36	0.000		4x4	98	439	341		box		14	$56,007	
LP2A5A	154	0.005	66		201	265	64	par	culvert	42		$32,319	
LP1D4	421	0.007	21		13	21	8	rep	pipe	27		$47,354	
LP2A2	78	0.006		10x3	157	675	518		box		33	$230,549	$650,114
Airport Road													
LP1A12	115	0.000	18		8	11	3	rep	culvert	21		$10,382	
LP1A10	46	0.000	18		8	11	3	rep	culvert	21		$4,153	
LP1A6	107	0.037	18		8	14	6	rep	culvert	24		$10,962	
LP1A3	239	0.001	18		3	51	48	3	pipe	30		$89,313	
LP1A2	689	0.003	30		24	51	27	2	pipe	27		$154,997	
LP1A1	708	0.002	18		5	51	46	3	pipe	30		$264,576	
LP1B3	70	0.007	18		8	27	19		culvert	30		$8,720	
LP1B1	42	0.005	18		8	27	19		culvert	30		$5,232	$548,334
Other structural costs												$438,000	$438,000
										Drainage Basin Total =			$2,605,075

Selected Arrangement Codes: box = box culvert, par = parallel culvert, rep = replacement, 1 or 2 or 3 = number of parallel pipes

Date: 09/13/96 J:\2119\COSTEST\SUMMARY\LPSUM.WB1

Table 4-2.3 Lone Pine Creek
Open Channel Flows

Element (Tag)	Channel Length	Slope	Controlling Storm	Modeled Flows (cfs)
LP1A4	1112	0.0095	10sz	24
LP1A7	492	0.0203	10sz	11
LP1A9	870	0.0017	10sz	11
LP1A11	112	0	10sz	11
LP1B2	500	0.007	10sz	27
LP1B4	900	0.0089	10sz	27
LP1B6	425	0.0188	10sz	0
LP1B7	1400	0.0014	10sz	0
LP1D1	905	0.0017	10sz	53
LP1D3	1625	0.0003	10sz	53
LP1F1	250	0.0069	10sz	9
LP1L4	88	0.0282	10wz	35
LP1L7	250	0.022	10sz	11
LP1L8	608	0.0159	10sz	11
LP1L10	450	0.0246	10sz	11
LP1L11	700	0.0386	10wz	17
LP1L13	520	0.007	10wz	17
LP1N3	431	0.029	25sz	245.81
LP1N6	382	0.0085	10wz	142
LP1N8	1230	0.0685	10wz	132
LP1P3	1250	0.096	10sz	66
LP2A1	3000	0.004	25sz	674.62
LP2A3	2900	0.0081	25sz	554.29
LP2A4	2450	0.0034	25sz	516.65
LP2A6	1720	0.0077	25sz	465.4
LP2A8	380	0.0174	25sz	438.54
LP2A11	500	0.0082	25sz	400.14
LP2A13	1648	0.007	25sz	400.14
LP2A16	808	0.009	25sz	331.21
LP2A18	420	0.0136	25sz	331.21
LP2A20	928	0.0135	25sz	64.4
LP2A22	1132	0.0158	25sz	63.76
LP2A24	4544	0.0154	10wz	41

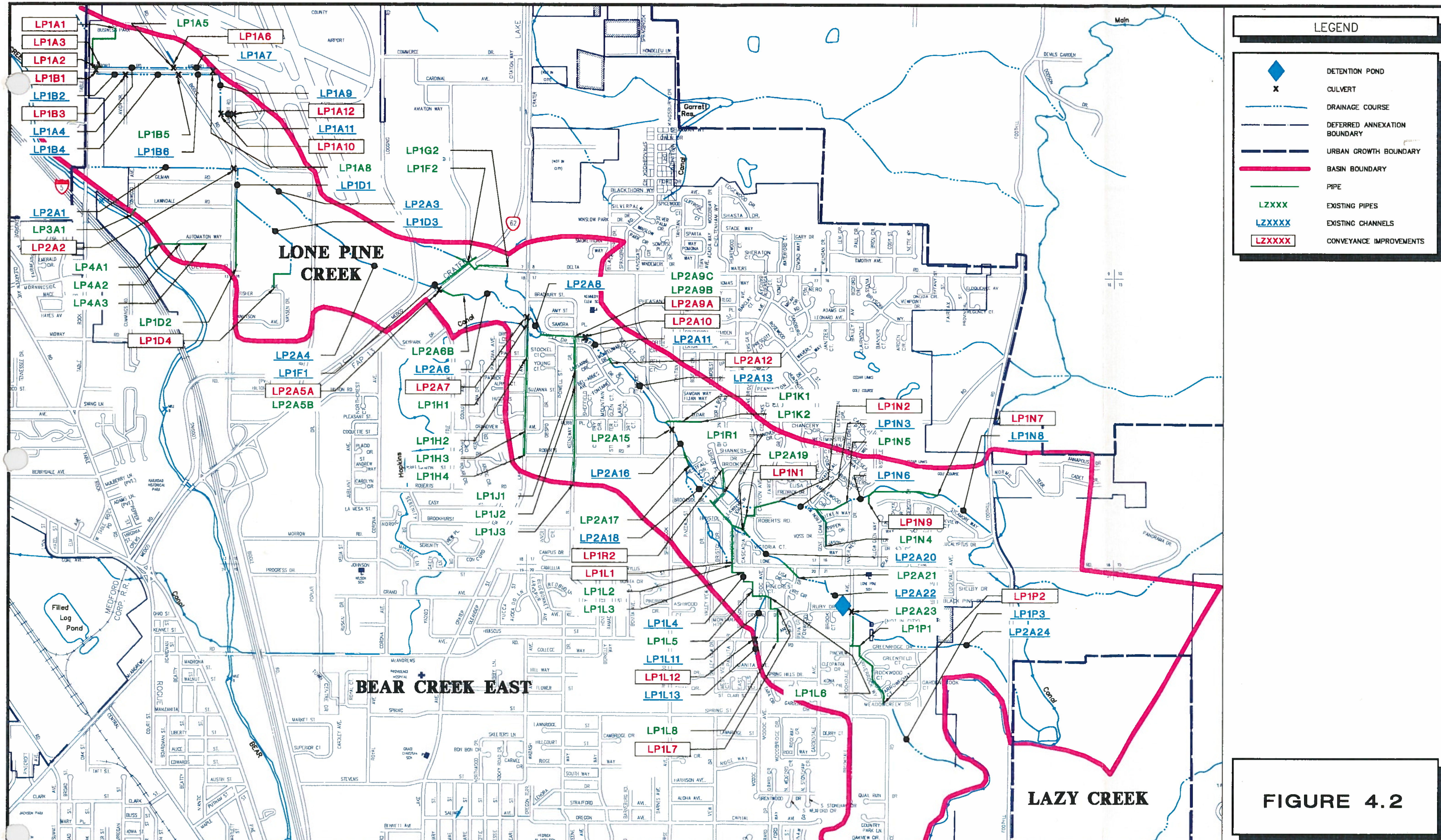


FIGURE 4.2

BROWN AND CALDWELL
Portland, Oregon
(503) 244-7005

CITY OF MEDFORD

North
0 800 1600
Scale in Feet

Drainage Master Plan

LONE PINE CREEK
DETENTION, 12.5 ACRE-FOOT

Table 4.2.2 -- Non-CIP Segments

Lone Pine Creek

Future Condition – 12.5 A.F. Detention Pond

Date: September 96

Element (Tag)	Pipe Length (feet)	Pipe (P) Culvert (C) or Other (O) ?	Depth to Invert (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Percent of Capacity
LP1P1	710	P	11	0.010	36		67	66	99%
LP2A23	145	C	11	0.020		8x4	196	133	68%
LP2A21	246	P	11	0.013	66		388	64	16%
LP1N5	699	P	5.5	0.026	42		163	145	89%
LP1N4	578	P	3.5	0.014	18		13	8	62%
LP1L6	426	P	4	0.016	24		28	25	89%
LP1L5	388	P	4.5	0.011	30		43	35	81%
LP1L3	122	P	4.5	0.009	30		39	35	90%
LP1L2	22	P	11	0.236	30		200	35	18%
LP2A19	1140	P	11	0.018		8x4	591	303	51%
LP1R1	190	P	4	0.020	24		32	12	38%
LP2A17	310	P	11	0.007		9x4.5	523	331	63%
LP1K2	313	P	3.5	0.032	18		19	6	32%
LP1K1	384	P	3.75	0.014	21		19	6	32%
LP1J3	1976	P	4.5	0.006	30		32	14	44%
LP1J2	122	P	4	0.067	24		58	14	24%
LP1J1	638	P	4.5	0.014	30		48	25	52%
LP2A9B	511	P	6	0.006	48		110	110	100%
LP2A9C	511	P	6	0.006	48		110	110	100%
LP1H4	425	P	3.5	0.004	18		7	7	100%
LP1H3	1297	P	5	0.006	36		50	19	38%
LP1H2	502	P	4.5	0.027	30		68	19	28%
LP1H1	273	P	5	0.003	36		39	22	56%
LP2A5B	154	C	7.5	0.005	66		201	201	100%
LP1G2	708	P	3.5	0.012	18		11	9	82%
LP1F2	750	P	3.5	0.012	18		11	9	82%
LP1D2	999	P	3.5	0.007	18		9	0	0%
LP1A8	30	C	11	0.017		5x2	41	11	27%
LP1A5	70	P	4	0.071	24		61	14	23%
LP1B10	104	C	3.5	0.029	18		8	0	0%
LP1B9	104	C	3.5	0.019	18		8	0	0%
LP1B8	96	C	3.5	0.021	18		8	0	0%
LP1B5	190	P	3.5	0.037	18		20	0	0%
LP3A1	200	P	3.75	0.020	21		22	9	41%
LP4A3	440	P	3.5	0.009	18		10	8	80%
LP4A2	120	P	3.75	0.008	21		14	8	57%
LP4A1	320	P	4.25	0.006	27		23	8	35%

Bear Creek East

The Bear Creek East basin includes about 2400 acres in the central part of the Medford drainage study area. Most of the basin is relatively flat. Its maximum elevation of a little over 1500 feet occurs in the southeast near Ruhl Park. The lowest point in the system is in the northeast where it joins Bear Creek at 1300 feet in elevation. The average slope of the system is 0.012 ft/ft.

The Hopkins irrigation canal parallels Corona Avenue before turning west along McAndrews Road. The canal runs between the 1340-and 1345-foot contours for most of its length in the Bear Creek East basin. The canal provides much of the stormwater conveyance system for the northeast section of the basin.

The build-out condition of Bear Creek East precludes the existence of many wetlands in the basin. The largest wetland in the basin (3-acres) is located near the intersection of McAndrews Road and Springbrook Road. This wetland will impact development projects in that area.

Most of Bear Creek East is zoned residential (77 percent). An area bounded by McAndrews Road to the north and Spring Street to the south is zoned service commercial and represents 22 percent of the basin. Full (100 percent) build-out was assumed for both the existing and future scenarios. Alternative 1, the conveyance alternative, is the recommended alternative. The recommended alternative is shown as Figure 4-3.1 and 4-3.2.

RECOMMENDED ALTERNATIVE	
Alternative 1, Conveyance	**$5,302,000**

The existing and future build-out conditions were considered equivalent since the basin is near full development at this time. Accordingly, a single model run represented both the existing and future condition conveyance alternative. This basin has over 250 separate segments, representing 18.4 miles of conveyance system, more than any of the other basins.

Due to the numerous, shorter pipe segments found in the basin, peak flows came from the more intense summer storms rather than from the longer duration winter storms. The 25-year summer storm controls peak flows in a few segments of Hopkins Canal. The 10-year summer storm controls the design for the balance of the system.

The modeling results showed that pipes were undersized throughout the system. Only in a few cases, such as the recently installed pipes (BE7D and BE7J series) near Grace Christian School between Royal and Crater Lake Avenues, south of Spring Street, do the existing pipes appear adequately sized.

The pond alternative represented a minor savings on capital costs; however, the decreased flow rate provided by the pond would not have significantly decreased peak flow rates in other segments of the drainage system. Land acquisition, maintenance access, and maintenance costs detracted from the water quality and aesthetic benefits provided by the pond.

Bear Creek East is the basin with the most conveyance system and thus has the largest number of upgrade projects, twenty (Table 4-3.1). The projects are Main Street, East 9th Street, Eastwood, Barneburg, Witham, Hilton Road, Biddle Road, Morrow Road, Grand Avenue, Poplar Drive, Royal, Buckshot, Brookhurst, Alcan Drive, Sunrise, Oregon Avenue, Gardendale, Providence, and Queen Anne. The costs for the projects vary by more than tenfold, from $79,000 to $962,000.

Physical information on the elements of the drainage system not requiring improvement are shown in Table 4-3.2. The design flows for the open channel segments of the drainage system are shown in Table 4-3.3.

Drainage Basin: Bear Creek East

Table 4-3.1 Recommended Alternative: conveyance

Element (Tag)	Pipe Length (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Excess Flow (cfs)	Selected Arrangement	Selected Convey	Selected Pipe Diameter (in) or Height (ft)	If Box Culvert Additional Width (ft)	Total Element Cost	Total Project Cost
Main Street													
BE11A2A	331	0.0043	12		2	5	3	rep	pipe	18		$27,751	
BE11A2B	331	0.0043	12		2	5	3	rep	pipe	18		$27,751	
BE11A3	255	0.0059	18		8	11	3	rep	pipe	21		$23,020	$78,522
East 9th Street													
BE12A1	444	0.0014	24		8	12	4	rep	pipe	30		$55,307	
BE12A2	164	0.0036	18		6	12	6	rep	pipe	24		$16,802	$72,108
East 10th Street													
BE13A1	406	0.0076	24		20	33	13	rep	pipe	30		$50,573	
BE13A2A	215	0.0153	12		4	10	6	rep	pipe	18		$18,026	
BE13A2B	215	0.0153	12		4	10	6	rep	pipe	18		$18,026	
BE13A3	365	0.0010	18		3	20	17	rep	pipe	36		$52,339	
BE13B1	327	0.0012	18		4	13	9	rep	pipe	30		$40,733	$179,697
Eastwood													
BE14A1	1277	0.0049	24		16	31	15	rep	pipe	36		$183,116	
BE14A2	218	0.0048	30		28	31	3	rep	pipe	36		$31,260	
BE14A3	151	0.0072	24		19	31	12	rep	pipe	30		$18,809	$233,185
Barneburg													
BE15A10	975	0.0193	24		31	44	13	rep	pipe	30		$121,451	
BE15A2	151	0.0330	24		41	72	31	rep	pipe	30		$18,809	
BE15A3	134	0.0033	36		38	72	34	1	pipe	36		$19,215	
BE15A7	489	0.0166	30		53	60	7	rep	pipe	36		$70,120	
BE15A9	150	0.0133	24		26	44	18	rep	pipe	30		$18,685	$248,280
Witham													
BE1A11	24	0.0021	24		10	16	6	rep	pipe	30		$2,990	
BE1A12	550	0.0021	24		10	16	6	rep	pipe	30		$68,511	
BE1A8	235	0.0029	24		12	16	4	rep	pipe	27		$26,433	
BE1G1	185	0.0035	24		13	16	3	rep	pipe	27		$20,809	
BE1G2	54	0.0056	21		12	16	4	rep	pipe	24		$5,532	
BE1G3	184	0.0027	21		8	16	8	rep	pipe	27		$20,696	
BE1G4	324	0.0026	18		5	16	11	rep	pipe	30		$40,359	$185,329
Hilton Road													
BE1A3	33	0.0045	48		91	114	23	par	culvert	30		$4,717	
BE1B13	402	0.0011	30		14	24	10	1	pipe	27		$45,217	
BE1C4	70	0.0057	18		8	10	2	rep	pipe	21		$6,319	
BE1F4	185	0.0007	36		18	21	3	1	pipe	21		$16,701	$72,953

Drainage Basin: Bear Creek East
Table 4-3.1 Recommended Alternative: conveyance

Element (Tag)	Pipe Length (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Excess Flow (cfs)	Selected Arrangement	Selected Convey	Selected Pipe Diameter (in) or Height (ft)	If Box Culvert Additional Width (ft)	Total Element Cost	Total Project Cost
Biddle Road													
BE2A1	433	0.0039	24		14	30	16	rep	pipe	36		$62,090	
BE2A2	520	0.0038	24		14	30	16	rep	pipe	36		$74,566	
BE2A3	510	0.0020	24		10	22	12	rep	pipe	36		$73,132	
BE2A4	504	0.0018	24		10	22	12	rep	pipe	36		$72,271	
BE2A5	400	0.0018	18		4	22	18	rep	pipe	36		$57,358	
BE2A6	452	0.0063	18		8	22	14	rep	pipe	27		$50,841	$390,257
Morrow Road													
BE3A1	633	0.0053	36		49	71	22	1	pipe	27		$71,200	
BE3A2	897	0.0044	30		27	65	38	2	pipe	27		$201,788	
BE3A3	533	0.0024	30		20	49	29	2	pipe	27		$119,903	
BE3A5	440	0.0032	24		13	16	3	rep	pipe	27		$49,491	
BE3A6	40	0.0050	18		7	11	4	rep	pipe	21		$3,611	
BE3C1	651	0.0020	18		5	19	14	rep	pipe	36		$93,350	
BE3D1	364	0.0032	18		6	16	10	rep	pipe	27		$40,943	$580,286
Grand Avenue													
BE3E1	400	0.0050	24		16	19	3	rep	pipe	27		$44,992	
BE3E2	205	0.0049	24		16	19	3	rep	pipe	27		$23,058	
BE3E3	368	0.0052	24		16	19	3	rep	pipe	27		$41,392	
BE3E4	149	0.0047	24		16	19	3	rep	pipe	27		$16,759	
BE3E5A	42	0.0048	18		7	9	2	rep	pipe	21		$3,792	
BE3E5B	42	0.0048	18		7	9	2	rep	pipe	21		$3,792	
BE3E6	158	0.0051	24		16	19	3	rep	pipe	27		$17,772	$151,557
Poplar Drive													
BE4A5	388	0.0034	24		13	23	10	rep	pipe	30		$48,331	
BE4A6	375	0.0025	24		11	23	12	rep	pipe	36		$53,773	
BE4A8	275	0.0030	24		12	23	11	rep	pipe	36		$39,434	
BE4A9	260	0.0014	24		8	23	15	rep	pipe	36		$37,283	
BE4A10	240	0.0024	18		5	23	18	rep	pipe	36		$34,415	$213,236
Royal													
BE7B1	75	0.0035	18		6	18	12	rep	pipe	27		$8,436	
BE7C1	342	0.0021	24		10	41	31	3	pipe	24		$105,113	
BE7C2	650	0.0060	18		8	41	33	rep	pipe	36		$93,207	$206,755

Drainage Basin: Bear Creek East

Table 4-3.1 Recommended Alternative: conveyance

Element (Tag)	Pipe Length (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Excess Flow (cfs)	Selected Arrangement	Selected Convey	Selected Pipe Diameter (in) or Height (ft)	If Box Culvert Additional Width (ft)	Total Element Cost	Total Project Cost
Oregon Avenue													
BE7J13	52	0.0362	18		20	26	6	rep	pipe	21		$4,694	
BE7J14	482	0.0284	18		18	26	8	rep	pipe	21		$43,512	
BE7J15	1782	0.0223	18		16	26	10	rep	pipe	24		$182,564	
BE7J16	49	0.0010	24		7	26	19	3	pipe	24		$15,060	$245,830
Gardendale													
BE7N1	728	0.0250	24		36	50	14	rep	pipe	30		$90,683	
BE7N2	50	0.0056		2.4' x 1.5'	6.5	30	24	rep	pipe	30		$6,228	
BE7N3	1296	0.0124	24		25	30	5	rep	pipe	27		$132,838	
BE7N6	18	0.0056	21		12	15	3	rep	pipe	24		$1,844	$231,593
Providence													
BE7U1	94	0.0083	18		10	26	16	rep	pipe	27		$10,573	
BE7W1	494	0.0156	24		28	31	3	rep	pipe	27		$55,565	
BE7W2	90	0.0389	18		21	31	10	rep	pipe	21		$8,125	
BE7X1	240	0.0279	18		18	27	9	rep	pipe	24		$24,588	$98,851
Queen Anne													
BE8C3	140	0.0050	18		7	11	4	rep	pipe	21		$12,638	
BE9B4	892	0.0040	36		42	50	8	1	pipe	21		$80,525	
BE9B8	331	0.0330	18		19	21	2	rep	pipe	21		$29,881	
BE9C2	360	0.0060	18		8	10	2	rep	pipe	21		$32,499	$155,543
Other structural costs													
										Drainage Basin Total =			$5,302,338

Selected Arrangement Codes: box = box culvert, par = parallel culvert, rep = replacement, 1 or 2 or 3 = number of parallel pipes

Date: 09/17/96 J:\2119\COSTEST\SUMMARY\BESUM.WB1

Drainage Basin: Bear Creek East

Table 4-3.1 Recommended Alternative: conveyance

Element (Tag)	Pipe Length (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Excess Flow (cfs)	Selected Arrangement	Selected Convey	Selected Pipe Diameter (in) or Height (ft)	If Box Culvert Additional Width (ft)	Total Element Cost	Total Project Cost
Buckshot													
BE7E1	322	0.0205	30		59	67	8	rep	pipe	36		$46,173	
BE7E2	34	0.0103	30		42	67	25	rep	pipe	36		$4,875	
BE7E3	364	0.0113	30		44	67	23	rep	pipe	36		$52,196	
BE7E4	178	0.0130	30		47	59	12	rep	pipe	36		$25,524	
BE7E5	612	0.0126	30		46	59	13	rep	pipe	36		$87,758	
BE7E7	353	0.0157	30		51	59	8	rep	pipe	36		$50,619	
BE7E9	356	0.0146	27		37	59	22	rep	pipe	36		$51,049	
BE7E12A	1390	0.0014	15		2	5	3	rep	pipe	21		$125,481	
BE7E12B	1390	0.0014	15		2	5	3	rep	pipe	21		$125,481	
BE7E13	40	0.0467	18		8	11	3	rep	culvert	21		$3,611	$572,767
Brookhurst													
BE7F1	80	0.0138		6' x' 3.5'	216	332	116	1	pipe	27		$10,385	
BE7F3	557	0.0094		6' x 3.5'	173	332	159	1	pipe	42		$105,458	
BE7F4	96	0.0172	48		189	332	143	1	pipe	48		$20,432	
BE7F5	132	0.0066	48		117	332	215	2	pipe	48		$56,187	
BE7F6	502	0.0119	48		157	332	175	2	pipe	42		$190,089	
BE7F7	462	0.0139	48		170	290	120	1	pipe	48		$98,327	
BE7F7A	203	0.0231	48		219	311	92	1	pipe	36		$36,066	
BE7F8	972	0.0097	48		142	270	128	1	pipe	48		$206,869	
BE7F9	278	0.0110		5.4' x 3.3'	72	270	198	1	pipe	36		$49,390	
BE7F9A	171	0.0119		5.4' x 3.3'	72	270	198	1	pipe	30		$24,441	
BE7F11	116	0.0137	30		48	69	21	rep	pipe	36		$16,634	
BE7F14	1038	0.0037	42		61	69	8	1	pipe	21		$109,567	
BE7K1	142	0.0050	18		7	13	6	rep	pipe	24		$14,548	
BE7L1	210	0.0022	18		5	13	8	rep	pipe	27		$23,621	$962,013
Alcan Drive													
BE7G1	125	0.0050	18		7	30	23	rep	pipe	36		$17,924	
BE7G2	137	0.0030	24		12	27	15	rep	pipe	36		$19,645	
BE7G4	270	0.0259	18		17	20	3	rep	pipe	21		$24,374	
BE7G5	635	0.0077	18		9	14	5	rep	pipe	24		$65,055	$126,999
Sunrise													
BE7H1	750	0.0128	30		46	114	68	2	pipe	27		$168,719	
BE7H2	416	0.0171	24		30	98	68	3	pipe	24		$127,856	$296,576

Figure 4.3.2 -- Non-CIP Segments

Bear Creek East
Future Condition: Conveyance
Date: September 96

Element (Tag)	Pipe Length (feet)	Pipe (P) Culvert (C) or Other (O) ?	Depth to Invert (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Percent of Capacity
BE10A1	438	P	10.75	0.0120	24		25	12	48%
BE11A1	316	P	2.9	0.0237	18		16	11	69%
BE14A4	269	P	4.48	0.0110	30		43	31	72%
BE15A1	88	P	3.7	0.0170	36		87	72	83%
BE15A11	760	P	3.7	0.0220	24		34	28	82%
BE15A12	344	P	4	0.0378	24		44	28	64%
BE15A4	56	P	4.06	0.0511	30		93	72	77%
BE15A5	380	P	3.7	0.0274	30		68	72	106%
BE15A6	534	P	5.3	0.0256	30		66	60	91%
BE15A8	708	P	4.5	0.0233	30		63	60	95%
BE15B1	167	P	3	0.0210	18		15	12	80%
BE1A1	450	P	5.91	0.0058		10'x3'	288	126	44%
BE1A10	167	P	3.29	0.0096	24		22	16	73%
BE1A13	538	P	4.5	0.0107	21		16	16	100%
BE1A6	296	P	6	0.0061	48		112	50	45%
BE1A7	205	P	5.7	0.0067	24		19	16	84%
BE1A9	59	P	3.64	0.0059	24		17	16	94%
BE1B10	26	P	6.01	0.0131	42		115	34	30%
BE1B11	55	P	5.67	0.0440	42		211	34	16%
BE1B12	400	P	5.25	0.0028	36		35	24	69%
BE1B14	453	P	6.68	0.0060	24		18	11	61%
BE1B2	61	C	4.75	0.0066	48		91	65	71%
BE1B4	73	C	5.9	0.0014	42		65	50	77%
BE1B6	126	P	5.88	0.0054	54		145	50	34%
BE1B7	116	P	6.2	0.0015	48		56	34	61%
BE1B8	411	P	8.03	0.0035	48		85	34	40%
BE1B9	345	P	6.6	0.0017	42		42	34	81%
BE1C1	149	P	6.25	0.0112	24		24	10	42%
BE1C2	36	P	6.58	0.0150	24		28	10	36%
BE1C3	462	P	6.04	0.0097	24		22	10	45%
BE1D1	135	P	5.18	0.0049	0	3' x 1.8'	16	13	81%
BE1D2	500	P	6.52	0.0047	0	3' x 1.8'	16	7	44%
BE1D3	187	P	10.17	0.0170	24		30	7	23%
BE1D4	397	P	8	0.0202	18		15	7	47%
BE1E1	273	P	4.15	0.0080	18		9	7	78%
BE1F1	50	P	4.14	0.0020		5' x 2.2'	47	21	45%
BE1F2	319	P	4.8	0.0028	42		53	21	40%
BE1F3	68	P	5.58	0.0188	36		92	21	23%
BE1F5	147	P	5.67	0.0012	36		23	21	91%
BE1H1	386	P	5.2	0.0175	30		54	14	26%
BE1J1	85	P	5.2	0.0141	18		12	6	50%
BE3A4	190	P	7.14	0.0118	30		45	35	78%
BE3B1	114	P	6	0.0152	18		13	6	46%
BE3F1	103	P	4.5	0.0049	18		7	5	71%
BE4A1	48	P	8.8	0.0235	30		63	35	56%
BE4A2	152	P	8.55	0.0078	0	7.7' x 5.4'	211	35	17%
BE4A3	417	P	8.75	0.0151	30		50	35	70%
BE4A4	212	P	8	0.0101	30		41	23	56%
BE4A7	180	P	6	0.0032	30		23	23	100%
BE5A1	230	P	8.2	0.0501	18		24	4	17%
BE6A1	328	P	8	0.0508	18		24	7	29%

Figure 4.3.2 -- Non-CIP Segments

Bear Creek East
Future Condition: Conveyance
Date: September 96

Element (Tag)	Pipe Length (feet)	Pipe (P) Culvert (C) or Other (O) ?	Depth to Invert (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Percent of Capacity
BE7A1	100	P	5.57	0.0655	36		171	626	0%
BE7A10	43	P	7	0.0001		12' x 5'	100	332	0%
BE7A11	50	C	7	0.0001		6' x 3.5'	120	332	0%
BE7A13	570	P	7	0.0001		6'x4'	31	43	0%
BE7A15	100	P	6.75	0.0020	48		64	43	0%
BE7A17	230	P	6.22	0.0001	36		7	27	0%
BE7A2	328	P	8.02	0.0050		10'x5'	570	626	0%
BE7A3	1080	P	11.38	0.0074		10'x5'	693	599	0%
BE7A4	840	P	8.36	0.0004		10'x5'	161	599	0%
BE7A5	60	P	8	0.0001		10'x5'	81	537	0%
BE7A6	370	P	8	0.0001		10'x5'	81	500	0%
BE7A7	400	P	8	0.0071		10' x 3'	319	359	0%
BE7A8	270	P	6.14	0.0042		8' x 4'	288	359	0%
BE7A9	1630	P	5.5	0.0001		8' x 4'	44	332	0%
BE7D1	85	P	5.17	0.0029		5' X 2.9'	85	33	39%
BE7D10	348	P	6.56	0.0138	48		169	33	20%
BE7D2	660	P	6.92	0.0045	48		97	33	34%
BE7D3	355	P	6.48	0.0046	48		98	33	34%
BE7D4	120	P	5.5	0.0220		6' X 2.5'	235	33	14%
BE7D5	800	P	4.86	0.0012	48		50	33	66%
BE7D6	385	P	6.4	0.0024	48		70	33	47%
BE7D7	260	P	6.47	0.0036	54		118	33	28%
BE7D8	385	P	5.54	0.0035	48		85	33	39%
BE7D9	610	P	5.7	0.0035	48		85	33	39%
BE7E10	297	P	4.08	0.0171	30		54	59	109%
BE7E11	1094	P	6	0.0181	24		30	11	37%
BE7E15	168	P	4.38	0.0308	18		18	11	61%
BE7F10	250	P	6.38	0.0138	36		78	69	88%
BE7F12	525	P	5.34	0.0130	42		115	69	60%
BE7F13	100	P	6.5	0.0650	30		105	69	66%
BE7F15	929	P	5.2	0.0278	36		111	69	62%
BE7F16	520	P	4.37	0.0122	36		74	69	93%
BE7F17	160	P	5	0.0313	30		73	19	26%
BE7F18	270	P	4	0.0352	30		77	19	25%
BE7F19	242.5	P	4.5	0.0087	24		21	19	90%
BE7F2	46	P	5.08	0.0054		7.3' x 4.3'	323	332	103%
BE7F20	426	P	2.3	0.0183	21		21	19	90%
BE7G3	400	P	5.07	0.0089	24		21	20	95%
BE7G6	609	P	4.6	0.0070	18		9	7	78%
BE7G7	156	P	5.33	0.0265	18		17	7	41%
BE7H4	135	P	7	0.0220	24		128	81	63%
BE7H5	330	P	3	0.0150	12		75	61	81%
BE7H7	170	P	10	0.0290	30		123	44	36%
BE7H8	1250	P	5	0.0380	18		121	26	21%
BE7J1	47	P	10.27	0.0079	48		128	107	84%
BE7J10	384	P	9.5	0.0055	42		75	45	60%
BE7J11	133.6	P	9.4	0.0150	42		123	45	37%
BE7J12	536	P	8.4	0.0327	36		121	45	37%
BE7J2	228	P	10.4	0.0039	48		90	90	100%
BE7J3	423	P	10.5	0.0113	42		107	90	84%
BE7J4	305	P	6.7	0.0077	42		88	90	102%

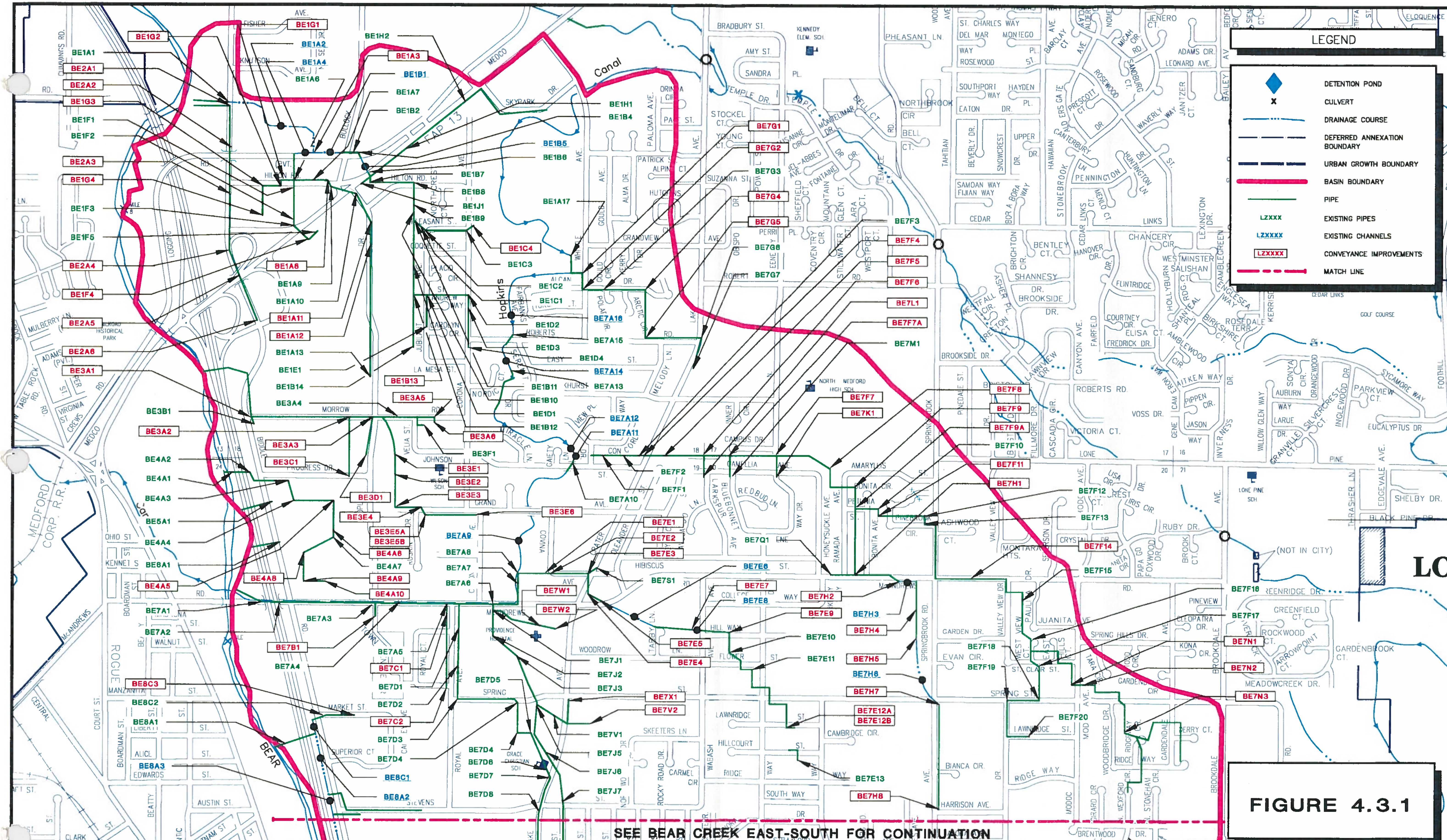
Figure 4.3.2 -- Non-CIP Segments

Bear Creek East
Future Condition: Conveyance
Date: September 96

Element (Tag)	Pipe Length (feet)	Pipe (P) Culvert (C) or Other (O) ?	Depth to Invert (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Percent of Capacity
BE7J5	100	P	7.36	0.0096	42		99	90	91%
BE7J6	285	P	6.4	0.0033	42		58	37	64%
BE7J7	637	P	6.47	0.0095	30		40	37	93%
BE7J8	660	P	9.44	0.0056	30		31	11	35%
BE7M1	142	P	2.9	0.0215	18		15	13	87%
BE7N4	404	P	2.9	0.0189	24		31	15	48%
BE7N5A	54	P	3.25	0.0176	15		9	7	78%
BE7N5B	54	P	3.25	0.0176	15		9	7	78%
BE7N7	369	P	3.2	0.0293	24		39	15	38%
BE7N8	156	P	3.37	0.0471	18		23	15	65%
BE7P1	327	P	3.5	0.0199	21		22	15	68%
BE7P2	377	P	3	0.0203	18		15	15	100%
BE7Q1	130	P	6.93	0.0235	18		16	16	100%
BE7S1	154	P	6.54	0.0279	18		18	10	56%
BE7V1	360	P	6.7	0.0156	30		51	53	104%
BE7V2	174	P	6.1	0.0186	24		31	27	87%
BE8A1	182	P	3.7	0.0080	48		129	51	40%
BE8B1	140	P	4.61	0.0161	36		85	22	26%
BE8B2	130	P	4.35	0.0258	24		36	22	61%
BE8B3	619	P	4	0.0032	30		23	22	96%
BE8B4	50	P	6	0.0100	24		23	22	96%
BE8C2	185	P	6.5	0.0042	24		15	11	73%
BE8D1	831	P	4.27	0.0089	24		21	20	95%
BE9A1	2358	P	2.77	0.0064	18		8	6	75%
BE9A2	275	P	4.75	0.0047	18		7	6	86%
BE9B5	287	P	6	0.0320	27		56	50	89%
BE9B6	297.5	P	5	0.0080	27		28	21	75%
BE9B7	414	P	4	0.0100	24		23	21	91%
BE9B1	1350	P	6.9	0.0039	48		90	53	59%
BE9B2	951	P	6.67	0.0123	42		112	53	47%
BE9B3	183	P	7	0.0030	42		55	55	100%
BE9C1	867	P	8	0.0044	30		27	10	37%

Table 4-3.3 Bear Creek East
Open Channel Flows

Element (Tag)	Channel Length	Slope	Controlling Storm	Modeled Flows (cfs)
BE1A2	1430	0.0052	10sz	126
BE1A4	100	0.0027	10sz	50
BE1B1	300	0.0075	10sz	65
BE1B3	110	0.0041	10sz	65
BE1B5	90	0.0102	10sz	50
BE7A12	1450	0	10sz	43
BE7A14	250	0.017	10sz	43
BE7A16	1300	0.0003	10sz	43
BE7A18	3400	0.0005	10sz	27
BE7E14	30	0.269	10sz	11
BE7E6	250	0.0272	10sz	59
BE7E8	70	0.0454	10sz	59
BE7H3	110	0.0182	10sz	81
BE7H6	660	0.0264	10sz	44
BE8A2	1900	0.0009	10sz	43
BE8A3	200	0.0017	10sz	43
BE8C1	500	0.0015	10sz	11



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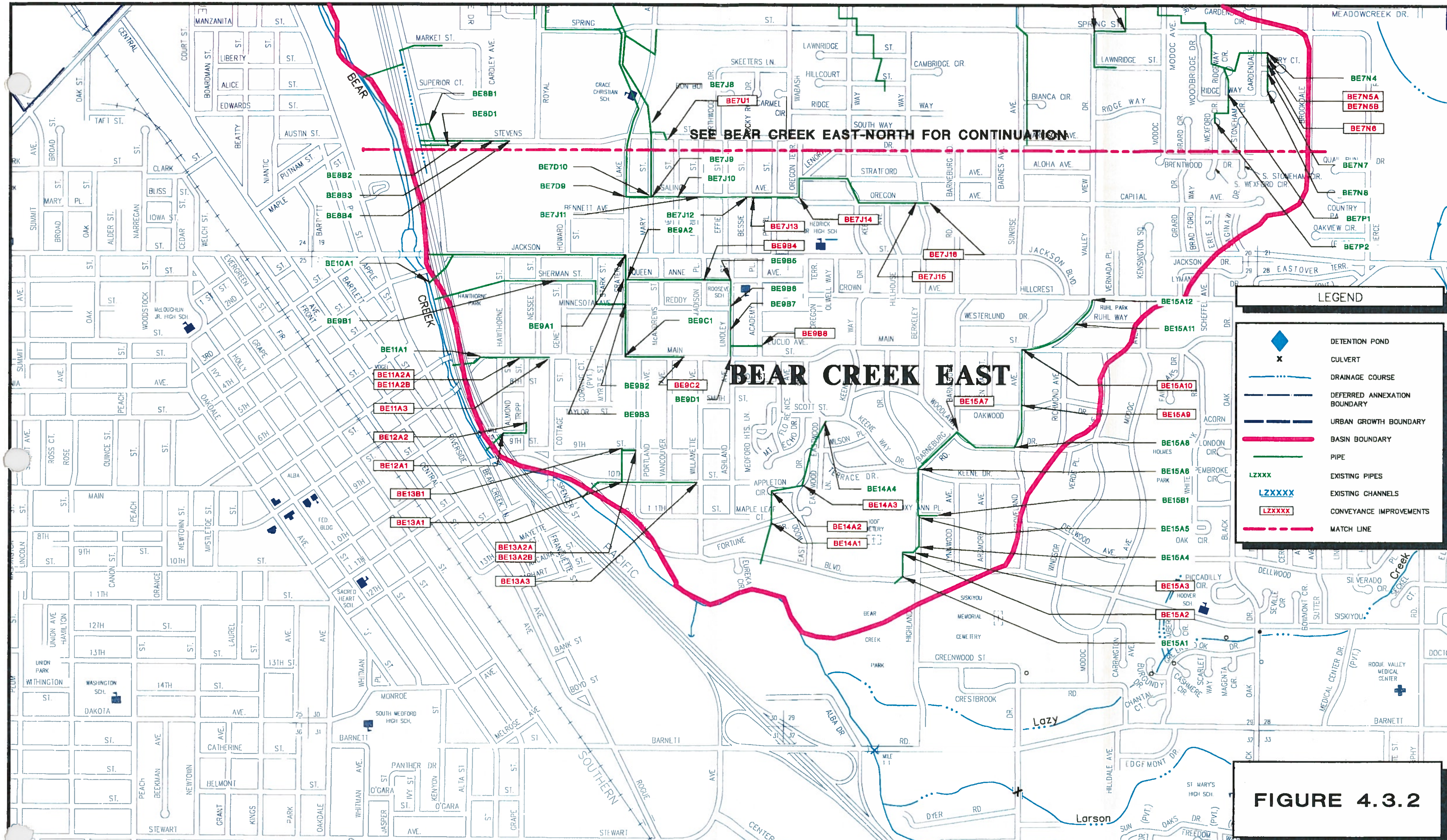
Scale In Feet

Drainage Master Plan

BEAR CREEK EAST NORTH VIEW
EXISTING SYSTEM



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Scale in Feet

Drainage Master Plan

BEAR CREEK EAST SOUTH VIEW

EXISTING SYSTEM

Lazy Creek

The Lazy Creek basin covers over 2700 acres in the southeast part of the Medford drainage area. In the eastern portion of the basin, Roxy Ann Peak has the highest elevation of about 3600 feet. The lowest point in the basin is at the confluence of Lazy Creek and Bear Creek at an elevation of just under 1400 feet. Downstream of Hemlock Drive, the basin has one main channel with an average slope of 0.028 ft/ft.

Stormwater in the upper reaches of the Lazy Creek basin is conveyed by open channel systems: ditches and streams, some of which are intermittent. The relief is great enough to ensure adequate capacity for most of this part of the system. Erosion is a concern in some of the steeper channel sections due to high velocities.

The East Main Canal runs along the 1560-foot contour and bisects the long, narrow basin to the north and east of the Rogue Valley Country Club.

Several smaller wetlands are located in the central area of the basin, particularly, near East Main Canal.

Most of the basin is zoned residential with some commercial use in the lowest sections of the basin. The riparian area along Lazy Creek and at the confluence of Lazy Creek and Bear Creek have park zoning. Overall, the basin is approximately 36 percent developed. Build-out decreases towards the upper end of the basin, particularly as the elevation increases in the hills. Future development in the higher elevations will have to contend with a moderate to severe potential for erosion. Alternative 2, a 30 acre-foot detention pond, is the recommended alternative. The recommended alternative is shown as Figure 4-4.

RECOMMENDED ALTERNATIVE	
Alternative 2, 30 acre-foot detention pond	**$3,728,000**

Building a 30 acre-foot detention pond downstream of Hemlock Drive would reduce the peak flow at segments downstream of this location by 100 to 150 cfs. A reduction in the peak flows will reduce the number of pipes requiring replacement and reduce the size requirements for those pipes that do need replacement. The recommended pond location is ideally sited hydrologically, but the small depth to bedrock would increase excavation costs. Constructing the pond in cooperation with the McAndrews Road Extension project would provide use of the excavated material (as a road grade), thus providing a cost savings.

The detention pond would also lessen erosion problems in some of the channel segments along the main stem due to decreased peak flows.

Although the capital cost of constructing a detention pond is higher than the conveyance solution, the linking of the detention pond to the McAndrews Road Extension will help offset the cost differential. The pond solution provides a water quality benefit and improves aesthetics and wildlife opportunities.

A number of elements are required to complete the recommended alternative (Table 4-4.1). The most important is the construction of the detention pond at $2 million. Many components of the conveyance system also need to be upgraded. Eleven projects have been identified based on location of the components to be upgraded. All but the Eagle Trace, Skycrest, and North Phoenix projects lie along the main stem of Lazy Creek. These include projects at Murphy Road, Siskyou Blvd., Oak Drive, Burgundy, Crestbrook Road, Ellendale Drive, Highland Drive, as well as some miscellaneous projects. The pond is the most expensive element at $2 million, while several of the pipe projects are less than $75,000.

Physical information on the elements of the drainage system not requiring improvement are shown in Table 4-4.2. The design flows for the open channel segments of the drainage system are shown in Table 4-4.3.

Drainage Basin: Lazy Creek
Table 4-4.1 Recommended Alternative: 30 acre-feet detention

Element (Tag)	Pipe Length (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Excess Flow (cfs)	Selected Arrangement	Selected Convey	Selected Pipe Diameter (in) or Height (ft)	If Box Culvert Width (ft)	Total Element Cost	Total Project Cost
Eagle Trace													
LZ1A37	780	0.074	48		182	201	19	1	pipe	18		$65,395	$65,395
Skycrest													
LZ1A34	50	0.200	48		101	314	213		box		13	$73,850	$73,850
North Phoenix													
LZ1A27	50	0.020	72		252	559	307		box		13	$81,638	
LZ1A25	50	0.002	72		249	568	319		box		13	$81,638	
LZ1A24	1120	0.014	72		502	568	66	1	pipe	36		$221,977	$385,253
Lazy Creek at Murphy Road													
LZ1A18	50	0.070		12x5	414	699	285		box		9	$62,213	$62,213
Lazy Creek at Siskyou Blvd.													
LZ1A14	120	0.004		12x4	295	797	502		box		21	$252,000	$252,000
Lazy Creek at Oak Drive													
LZ1A12	90	0.011		8x4	466	807	341	3	pipe	48		$57,464	
LZ1A11	300	0.010	84		640	807	167	1	pipe	54		$85,390	$142,854
Lazy Creek at Burgundy													
LZ1A8	70	0.007		12x3.5	240	877	637		box		32	$204,208	$204,208
Lazy Creek at Crestbrook Road													
LZ1A6	70	0.029		12x4	295	897	602		box		25	$168,805	$168,805
Lazy Creek at Ellendale Drive													
LZ1A4	70	0.007		12x4	295	911	616		box		26	$174,195	$174,195
Lazy Creek at Highland Drive													
LZ1A2	70	0.007	84		368	941	573		box		17	$141,610	$141,610
Lazy Creek Miscellaneous													
LZ1J2	80	0.009	24		16	40	24	rep	culvert	36		$11,472	
LZ1B1	510	0.015	18		13	17	4	rep	pipe	21		$46,040	$57,511
Other structural costs												$2,000,000	$2,000,000
										Drainage Basin Total =			$3,727,894

Selected Arrangement Codes: box = box culvert, par = parallel culvert, rep = replacement, 1 or 2 or 3 = number of parallel pipes

Date: 09/13/96

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Table 4.4.2 -- Non-CIP Segments

Lazy Creek

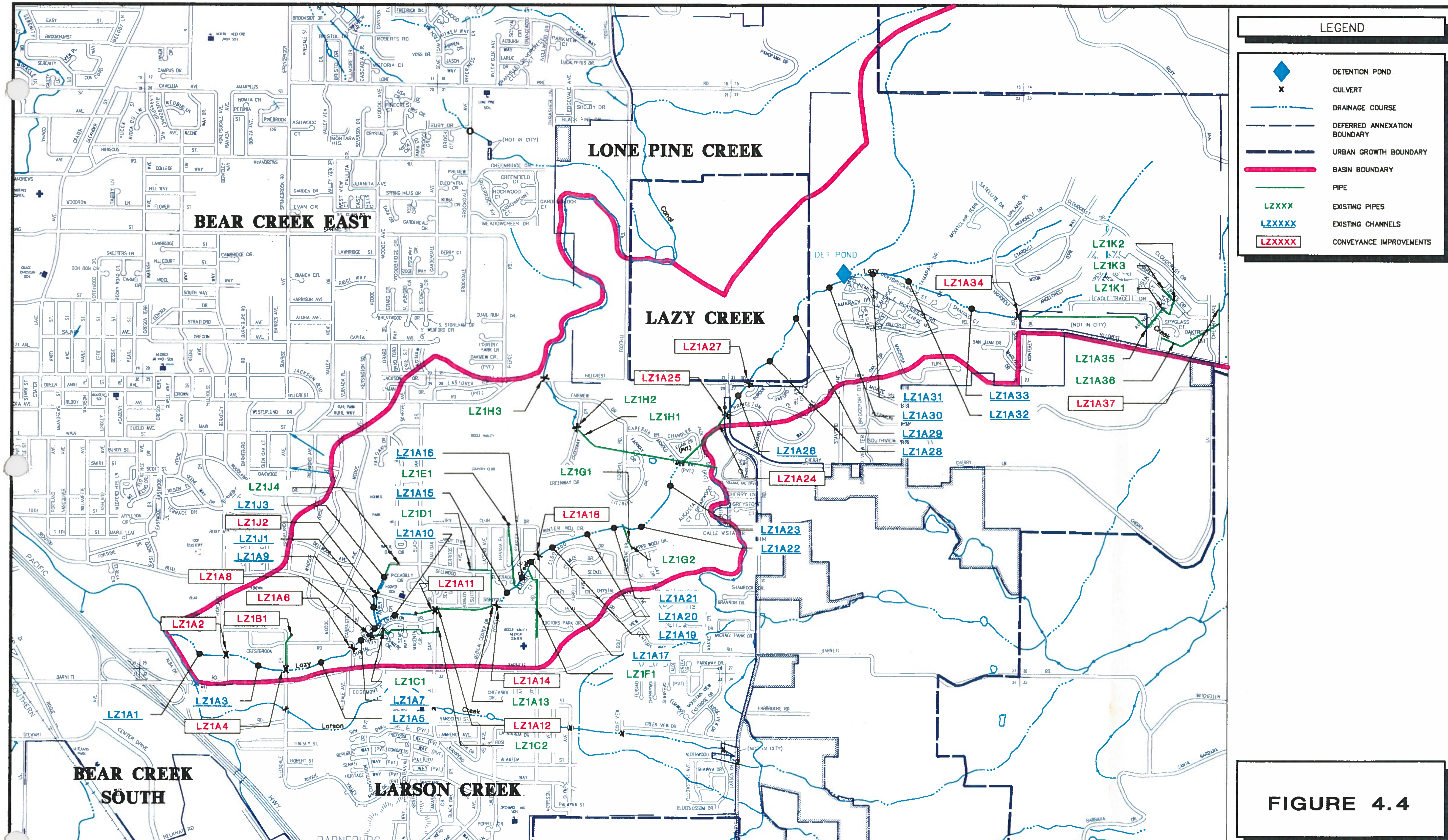
Future Condition: 30 A.F. Detention

Date: September 96

Element (Tag)	Pipe Length (feet)	Pipe (P) Culvert (C) or Other (O) ?	Depth to Invert (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Percent of Capacity
LZ1K3	215	P	6	0.007	24		19	18	95%
LZ1K2	285	P	6	0.054	18		24	18	75%
LZ1K1	400	P	6	0.055	24		53	18	34%
LZ1A36	925	P	6	0.035	48		269	201	75%
LZ1A35	2720	P	6	0.029	54		335	210	63%
LZ1H1	2480	O	7	0.022	NA		hand calc	39	
LZ1G2	11	P	3.5	0.155	18		41	25	61%
LZ1G1	34	P	4	0.062	24		56	25	45%
LZ1F1	18	P	4	0.317	24		128	23	18%
LZ1E1	950	P	3.5	0.025	18		65	33	51%
LZ1D1	870	P	3.5	0.024	18		16	14	88%
LZ1A13	1000	P	6.5	0.016		12x4	912	788	86%
LZ1C2	970	P	4	0.011	24		24	14	58%
LZ1C1	360	P	4.5	0.053	30		95	14	15%
LZ1J4	50	P	4	0.038	24		44	40	91%

Table 4-4.3 Lazy Creek
Open Channel Flows

Element (Tag)	Channel Length	Slope	Controlling Storm	Modeled Flows (cfs)
LZ1A1	1400	0.014	25yr	941
LZ1A10	680	0.012	25yr	823
LZ1A15	440	0.009	25yr	760
LZ1A16	360	0.018	25yr	718
LZ1A17	320	0.012	25yr	699
LZ1A19	800	0.018	25yr	699
LZ1A20	800	0.013	25yr	699
LZ1A21	80	0.036	25yr	681
LZ1A22	1200	0.024	25yr	636
LZ1A23	600	0.061	25yr	627
LZ1A26	520	0.019	25yr	559
LZ1A28	560	0.009	25yr	496
LZ1A29	1480	0.035	25yr	475
LZ1A3	1040	0.006	25yr	911
LZ1A30	600	0.033	25yr	466
LZ1A31	1040	0.05	25yr	446
LZ1A32	1240	0.073	25yr	344
LZ1A33	1280	0.063	25yr	313
LZ1A5	1320	0.012	25yr	897
LZ1A7	280	0.018	25yr	877
LZ1A9	240	0.013	25yr	823
LZ1H2	500	0.002	10yr	39
LZ1H3	2460	0	10yr	39
LZ1H4	2080	0	10yr	24
LZ1H5	2360	0.043	10yr	24
LZ1J1	450	0.031	10yr	40
LZ1J3	560	0.018	10yr	40



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Drainage Master Plan

LAZY CREEK
DETENTION, 30 ACRE-FOOT

Larson Creek

The Larson Creek drainage basin covers 5600 acres in the southeast part of the Medford drainage area. Its maximum elevation is in the hills southeast of Medford near Valley View Road. Starting at a height of about 4200 feet, the basin drops almost 3000 feet to discharge into Bear Creek at 1400 feet. A large portion of the drainage basin lies outside of the UGB.

The East Main Canal runs along the 1560-foot contour and bisects the basin from north to south near Phoenix Road and the city limits.

The Local Wetlands Inventory identified a linear wetland along the lower main stem of Larson Creek. A 3-acre wetland is located on the western edge of the St. Mary's High School property. Numerous other wetlands are located in the upper reaches of the basin. Future development will likely impact a number of these wetlands unless protection is provided.

The drainage basin is zoned residential for nearly 99 percent of the total area, including the area outside of the UGB. Other zoning includes service commercial, commercial, and parks which are located at several locations throughout the basin. The greatest potential for increased development lies in the eastern sections of the basin. Within the city limits, 61 percent of the area has been fully developed. Overall build-out is only 9 percent which includes those areas outside the city that contribute flows to the system. Areas developed on steep slopes will have to implement strict erosion control practices to prevent erosion. Alternative 1, the conveyance alternative, is the recommended alternative for Larson Creek. The recommended alternative is shown as Figure 4-5.

Only a few additional pipes and culverts will become undersized under future build-out conditions.

RECOMMENDED ALTERNATIVE	
Alternative 1, Conveyance	**$1,652,000**

Pipes such as LA1H3 represent major costs due to its length and diameter. Velocities in the upper channel reaches will also increase, aggravating erosion problems.

The shallow depth to bedrock makes the cost of constructing detention facilities costly. The multiple feeder streams in the upstream reaches also make the siting of detention facilities problematic, since a pond on one branch would not benefit reaches of the stream on a different branch. Opportunities for diversion were limited.

The pipe upgrades for the recommended alternative have been grouped into three projects, based on upgrade location (Table 4-5.1). The three projects are Larson Central, North Fork, and Black Oak. The costs for the projects range from $236,000 to $946,000.

Physical information on the elements of the drainage system not requiring improvement are shown in Table 4-5.2. The design flows for the open channel segments of the drainage system are shown in Table 4-5.3.

Drainage Basin: Larson Creek

Table 4-5.1 Recommended Alternative: conveyance

Element (Tag)	Pipe Length (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Excess Flow (cfs)	Selected Arrange-ment	Selected Convey	Selected Pipe Diameter (in) or Height (ft)	If Box Culvert Width (ft)	Total Element Cost	Total Project Cost
Larson Central													
LA1A17	50	0.010		10x7	572	806	234		box		5	$54,425	
LA1A11	46	0.001		12x5	414	1163	749		box		22	$103,765	
LA1A9	46	0.002		12x5	414	1163	749		box		22	$103,765	
LA1A7	48	0.002		16x5	552	1163	611		box		18	$93,324	
LA1E2	795	0.008	30		36	49	13	rep	pipe	36		$113,999	$469,277
North Fork													
LA1H4	50	0.035	52		113	256	143		box		10	$63,525	
LA1H3	1634	0.013	42		116	256	140	2	pipe	36		$580,604	
LA1H2B	673	0.018	42		134	256	122	1	pipe	42		$127,420	
LA1H2A	843	0.013	48		164	256	92	1	pipe	42		$159,607	
LA1G5	163	0.002	18		5	6	1	rep	pipe	21		$14,715	$945,871
Blackoak													
LA1A4	50	0.020		25x4	614	1241	627		box		26	$124,425	
LA1A2	39	0.013		12x5.5	478	1270	792		box		20	$83,402	
LA1B2	254	0.010	24		16	18	2	rep	culvert	27		$28,570	$236,396
										Drainage Basin Total =			$1,651,544

Selected Arrangement Codes: box = box culvert, par = parallel culvert, rep = replacement, 1 or 2 or 3 = number of parallel pipes

Date: 09/17/96 J:\2119\COSTEST\SUMMARY\LARSUM.WB1

Table 4.5.2 -- Non-CIP Segments

Larson Creek

Future Condition: Conveyance
Date: September 96

Element (Tag)	Pipe Length (feet)	Pipe (P) Culvert (C) or Other (O) ?	Depth to Invert (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Percent of Capacity
LA1A19	36	C	9.1	0.011		12x8	838	806	96%
LA1G4	589	P	5	0.016	18		13	7	54%
LA1G3	640	P	7.4	0.012	24		25	21	84%
LA1G2	526	P	3.8	0.033	24		41	21	51%
LA1E6	1397	P	8	0.013	30		47	13	28%
LA1E5	260	P	6.53	0.060	18		26	7	27%
LA1E4	270	P	9.22	0.023	24		34	7	21%
LA1E3	1920	P	7.35	0.020	24		32	19	59%
LA1E1	1337	P	5.2	0.007	36		54	49	91%
LA1F4	40	P	6.6	0.018	36		88	8	9%
LA1F3	855	P	6	0.009	24		21	8	38%
LA1F2	359	P	7.1	0.003	42		55	8	15%
LA1F1	182	P	7	0.003	42		56	8	14%
LA1D1	1094	P	7	0.059	18		26	27	104%
LA1C3	412	P	9.6	0.027	18		17	7	41%
LA1C2	80	P	11.7	0.021	36		96	7	7%
LA1C1	305	P	4.13	0.002	30		20	7	35%

Table 4-5.3 Larson Creek
Open Channel Flows

Element (Tag)	Channel Length	Slope	Controlling Storm	Modeled Flows (cfs)
LA1A1	1600	0.014	25wz	1294
LA1A3	2300	0.017	25wz	1260
LA1A5	1000	0.017	25wz	1216
LA1A6	900	0.014	25wz	1167
LA1A8	255	0.015	25wz	1163
LA1A10	250	0.009	25wz	1163
LA1A12	300	0.018	25wz	1163
LA1A13	700	0.011	25wz	875
LA1A14	50	0.020	25wz	875
LA1A15	1300	0.022	25wz	806
LA1A16	500	0.017	25wz	806
LA1A17	50	0.010	25wz	806
LA1A18	300	0.019	25wz	806
LA1A20	400	0.028	25wz	806
LA1B1	370	0.017	10sz	18
LA1B3	230	0.023	10sz	18
LA1G1	930	0.005	25wz	303
LA1H1	1720	0.016	25wz	286
LA1J1	920	0.010	10sz	20
LA1K1	2400	0.002	10wz	94

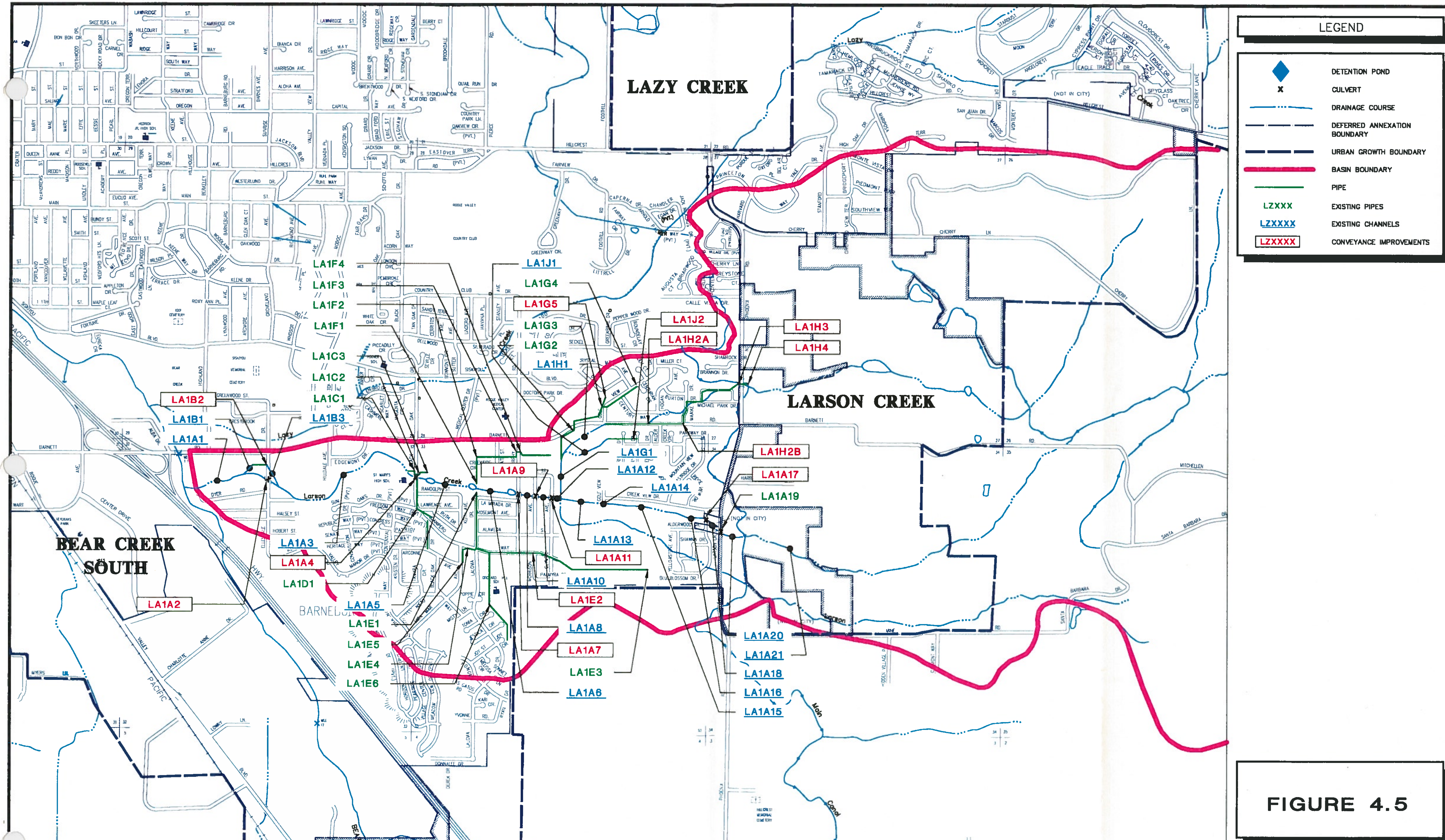

FIGURE 4.5

BROWN AND CALDWELL
Portland, Oregon
(503) 244-7005

CITY OF MEDFORD

North
0 800 1600
Scale In Feet

Drainage Master Plan

LARSON CREEK
PIPED SYSTEM

Crooked Creek/Bear Creek South

The drainage basins of Crooked Creek and Bear Creek South constitute almost 4600 acres along the southern edge of Medford. Of this, only about 70 acres contributes flow to the Bear Creek South system. All other drainage is through the Crooked Creek system. The highest elevation, 2400 feet, lies in the hills south of the South Stage Road. The elevation at which Crooked Creek joins Bear Creek lies at 1370 feet. Crooked Creek basin is dominated by its namesake stream, although an extensive piped system carries a large part of the flow.

The Phoenix Canal runs east to west at about 1500 feet in elevation just south of the South Stage Road. A little further south the Talent Lateral Canal parallels this.

Only one sizeable wetland (3.4 acres) was identified in the Crooked Creek basin. A nearly 11 acre wetland is located along Bear Creek in an undeveloped area. Several other smaller wetland are located throughout the Bear Creek basin.

Approximately, 95 percent of the drainage basin is zoned residential. Pockets of industrial and commercial zoning front Stewart Avenue. Increased development is likely in the southern sections of both of these drainage basins. Currently, the basin is only 63 percent developed. Alternative 1, the conveyance alternative, is the recommended alternative. The recommended alternative is shown as Figure 4-6.

RECOMMENDED ALTERNATIVE	
Alternative 1, Conveyance	**$2,196,000**

A large number of pipes require upgrading under the future build-out condition. Although a diversion alternative was briefly considered during preliminary alternative analysis, it quickly became apparent that the City has already invested a large amount of capital in upsizing pipes throughout much of the basin, in effect, already starting on a piped solution. The modeling validated this approach and identified several areas still requiring larger pipes.

Eleven pipe projects were identified (Table 4-6.1). Four of them were along the main channel of Crooked Creek at South State Road, at Kings Highway, near Dove Lane, and near Stewart Avenue. The remainder of the projects include: Center Drive, Stewart Avenue, Peach Street, Columbus Avenue, Kings Highway, South Gateway, and Hansen Creek. The project costs showed an extreme range, from $21,000 to $758,000.

Physical information on the elements of the drainage system not requiring improvement are shown in Table 4-6.2. The design flows for the open channel segments of the drainage system are shown in Table 4-6.3.

Drainage Basin: Crooked Creek/Bear Creek South
Table 4-6.1 Recommended Alternative: conveyance

Element (Tag)	Pipe Length (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Excess Flow (cfs)	Selected Arrangement	Selected Convey	Selected Pipe Diameter (in) or Height (ft)	If Box Culvert Additional Width (ft)	Total Element Cost	Total Project Cost
Center Drive													
BS1A6	265	0.001	33		16	36	20	2	pipe	30		$66,019	
BS1A7	125	0.001	30		28	36	8	rep	culvert	36		$17,924	$83,944
Crooked at South State Road													
CR1A12	100	0.001	60		158	226	68	par	culvert	48		$21,283	$21,283
Crooked at Kings Highway													
CR1A14	43	0.001		8x4	196	226	30		box		2	$26,789	$26,789
Crooked near Dove Lane													
CR1A8	325	0.001		10X5	271	415	144	2	pipe	60		$201,984	$201,984
Crooked near Stewart Avenue													
CR1A3	70	0.000		23X3.5	459	631	172		box		9	$78,890	
CR1A6	74	0.001		14X4	344	620	276		box		12	$103,600	$182,490
Stewart Avenue													
CR1B8	1029	0.004	60		42	54	12	1	pipe	24		$105,420	
CR1C2	854	0.004	24		14	22	8	rep	pipe	30		$106,378	
CR1D1	731	0.002	24		11	14	3	rep	pipe	27		$82,223	
CR1E1	586	0.004	18		7	10	3	rep	pipe	21		$52,901	$346,922
Peach Street													
CR1F4	455	0.001	24		7	14	7	rep	pipe	36		$65,245	
CR1F5	680	0.001	18		3	8	5	rep	pipe	27		$76,486	
CR1G2	346	0.003	18		6	7	1	rep	pipe	21		$31,235	$172,966
Columbus Avenue													
CR1H3	280	0.002	15		3	19	16	rep	pipe	36		$40,151	
CR1H4	161	0.003	18		6	19	13	rep	pipe	30		$20,055	$60,206
Kings Highway													
CR1J1	939	0.002	24		10	16	6	rep	pipe	30		$116,966	
CR1J2	1033	0.003	18		6	16	10	rep	pipe	27		$116,191	
CR1L2	346	0.001	18		3	7	4	rep	pipe	27		$38,918	$272,076
South Gateway													
CR1S4	253	0.005	24		16	27	11	rep	pipe	30		$31,515	
CR1S5	298	0.005	18		7	27	20	rep	pipe	30		$37,120	$68,635

Drainage Basin: Crooked Creek/Bear Creek South

Table 4-6.1 Recommended Alternative: conveyance

Hansen Creek													
CR2A1	704	0.007		6X3	176	298	122	3	pipe	36		$375,225	
CR2A2	70	0.001		8X3	126	279	153		box		10	$81,708	
CR2A4	50	0.001		10X2.5	118	279	161		box		14	$71,925	
CR2A4A	70	0.001		20X2.5	235	279	44		box		4	$46,305	
CR2A5	213	0.001		16X3	203	279	76	3	pipe	42		$101,761	
CR2B1	202	0.000	24		4	13	9	3	pipe	24		$62,084	
CR2C1	173	0.004	24		14	17	3	rep	pipe	27		$19,459	$758,466
Other structural costs													
										Drainage Basin Total =			$2,195,760

Selected Arrangement C box = box culvert, par = parallel culvert, rep = replacement, 1 or 2 or 3 = number of parallel pipes

Date: 09/17/96 J:\2119\COSTEST\SUMMARY\CRCSUM.WB1

Table 4.6.2 -- Non-CIP Segments

Crooked Creek/Bear Creek South
Future Condition: Conveyance
Date: September 96

Element (Tag)	Pipe Length (feet)	Pipe (P) Culvert (C) or Other (O) ?	Depth to Invert (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Percent of Capacity
BS1A1	600	P	7	0.002	60		103	44	43%
BS1A2	340	P	4.5	0.001	30		14	9	64%
BS1A3	525	P	6.5	0.002	54		88	36	41%
BS1A4	400	P	6	0.001	48		54	36	67%
BS1A5	394	P	5.5	0.003	42		54	36	67%
CR1A1	1391	P	11	0.009		12X8	1890	903	48%
CR1A13	36	C	9	0.001		9x6	409	226	55%
CR1A2	365	P	9.5	0.004		12x6.5	979	631	64%
CR1A4	80	C	7	0.000		20X5	690	631	91%
CR1A5	520	P	7	0.002		20X5	842	620	74%
CR1A9	1040	P	6.5	0.006	54		155	115	74%
CR1B1	506	P	11	0.001		12X8	602	146	24%
CR1B2	1100	P	6	0.003		8X4	257	111	43%
CR1B2A	600	P	6	0.002		8X4	198	130	66%
CR1B3	700	P	6	0.002		8X4	205	81	40%
CR1B4	900	P	6	0.005		8X4	312	71	23%
CR1B5	1350	P	6	0.007		8x3.5	303	47	16%
CR1B6	750	P	6	0.004		7x4	223	66	30%
CR1B7	550	P	5.5	0.002		5x4	117		50%
CR1B9	862	P	5	0.005	36		47	12	26%
CR1G1	627	P	3.75	0.003	21		8	7	88%
CR1H1	400	P	6	0.002	48		72	41	57%
CR1H1A	684	P	6	0.011	48		151	21	14%
CR1H2	640	P	5	0.007	36		57	41	72%
CR1L1	375	P	4	0.052	24		52	7	13%
CR1M1	2020	P	4	0.026	24		36	8	22%
CR1M1A	2020	P	4	0.026	24		36	19	53%
CR1P1	150	C	3.5	0.003	18		8	4	50%
CR1R1	549	P	4.5	0.007	30		34	12	35%
CR1R2	1408	P	4	0.040	24		45	12	27%
CR1S2	900	P	5	0.003	36		27	27	100%
CR1S3	430	P	4.5	0.004	30		27	27	100%
CR1T1	100	P	4.5	0.010	24		23	10	43%
CR1U1	50	C	4.5	0.010	24		16	11	69%
CR1W1	320	P	6	0.036	48		273	47	17%
CR1W2	100	P	6	0.097	48		448	37	8%
CR1W3	120	C	6	0.065	48		94	23	24%
CR1W4	320	P	6	0.086	48		422	13	3%

Table 4-6.3 Crooked Creek/Bear Creek South
Open Channel Flows

Element (Tag)	Channel Length	Slope	Controlling Storm	Modeled Flows (cfs)
CR1A10	4000	0.005	25wz	233
CR1A11	2240	0.020	25wz	226
CR1A7	3030	0.010	25wz	467
CR1C1	650	0.011	10sz	22
CR1S1	624	0.011	10sz	27
CR2A3	376	0.011	25sz	279

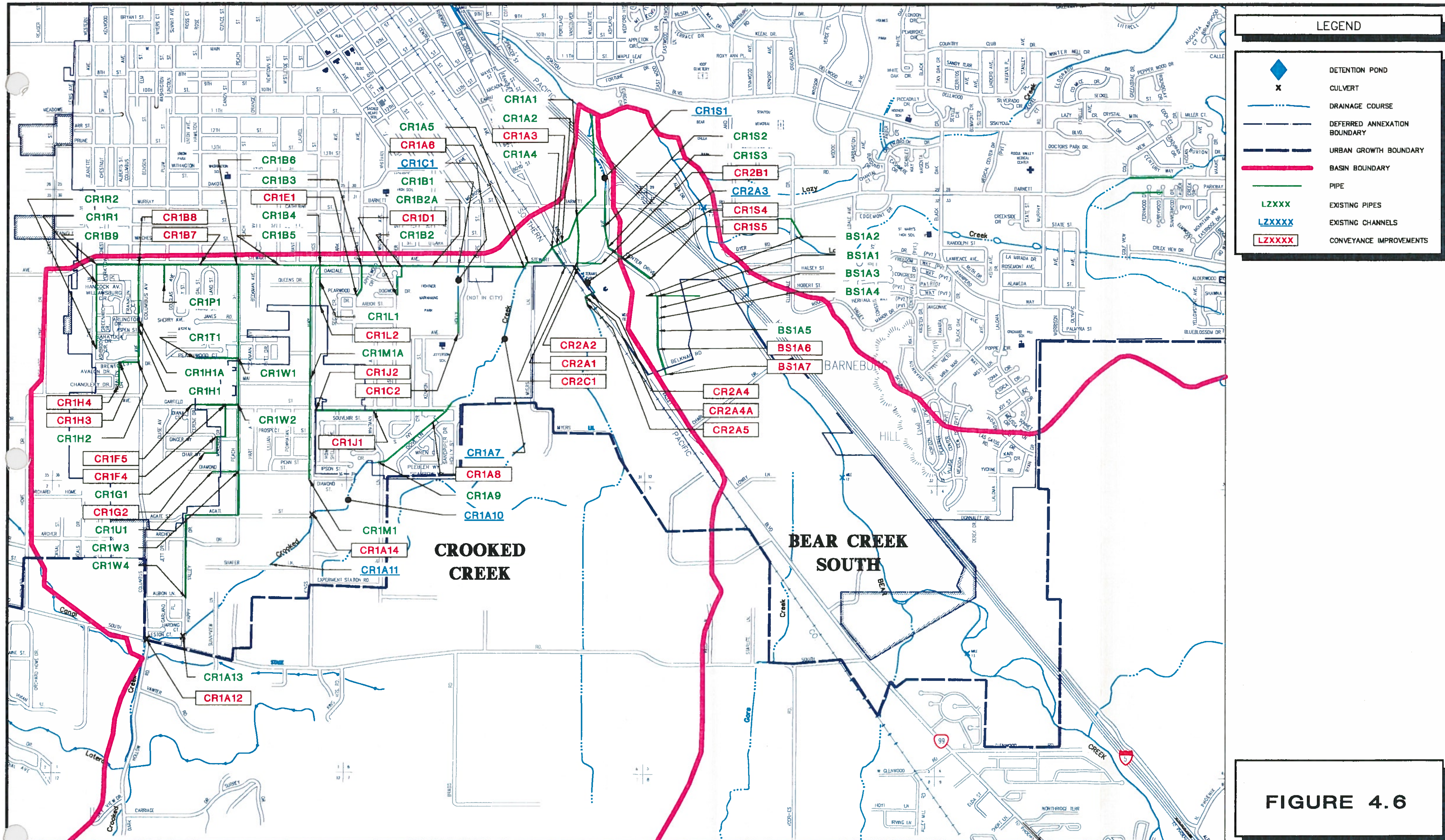

FIGURE 4.6

BROWN AND CALDWELL
Portland, Oregon
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CITY OF MEDFORD

Drainage Master Plan

CROOKED CREEK AND BEAR CREEK SOUTH
PIPED SYSTEM

Bear Creek West

Bear Creek West includes 1400 acres in the west central part of Medford. It contains about a hundred feet of vertical relief, from 1427 feet in the southwestern corner of the basin, to 1325 feet at its northern end.

The Local Wetlands Inventory does not identify any wetlands in the Bear Creek West basin.

The Bear Creek West drainage basin represents the oldest areas of the City. The majority of the area is residential (58 percent), but the commercial area represents 28 percent and the industrial area 14 percent of the land use. For modeling purposes, the basin was assumed to be completely developed according to the current zoning. Therefore, the existing condition and future condition scenarios are the same. Alternative 3, the 10th Street diversion (Diversion #2), is the recommended alternative. The recommended alternative is shown as Figure 4-7.

RECOMMENDED ALTERNATIVE	
Alternative 3, 10th Street diversion	**$6,207,000**

New pipe along Mistletoe (Alternative 2, 6th Street Diversion) will not be required if the diverted flows are routed east down 10th Street. Locating an upgraded pipe along 10th Street may be less difficult than 6th Street since a storm drain pipe currently exists under 10th Street. The 10th Street Diversion is $100,000 less expensive than the 6th Street alternative. The average slope is not as steep as the 6th Street route, meaning larger pipe is required. As with Alternative 2, this diversion alternative would lower the peak flows and substantially lessen the costs of new pipe along the main stem. The 10th Street alternative is the least expensive of the three alternatives and presents fewer construction and implementation issues.

Extensive upgrades of pipes in the system are needed even with the diversion alternatives. Nine groups of pipe upgrades were identified as potential projects (Table 4-7.1). Washington, NW Medford, Oak Street, Bear Creek West - Columbus, Jackson, 8th Street, West 10th, Earhart, and 6th Street are the projects that were identified. Projects all exceed $100,000 and three exceed $1 million. Extensive sections of pipe are undersized.

Physical information on the elements of the drainage system not requiring improvement are shown in Table 4-7.2. Bear Creek West does not contain any open channel segments within the drainage system.

Drainage Basin: **Bear Creek West**
Table 4-7.1 **Recommended Alternative:** **Diversion after BW1A10 to K7**

Element (Tag)	Pipe Length (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Excess Flow (cfs)	Selected Arrangement	Selected Convey	Selected Pipe Diameter (in) or Height (ft)	If Box Culvert Additional Width (ft)	Total Element Cost	Total Project Cost
Washington													
BW1A10	812	0.008	24		20	75.65	56	3	pipe	24		$249,566	
BW1A11	253	0.005	18		8	75.65	68	3	pipe	27		$85,372	
BW1A12	1971	0.008	24		21	26.66	6	rep	pipe	27		$221,697	
BW1A13	661	0.014	18		12	26.66	15	rep	pipe	27		$74,349	
BW1F1	1738	0.002	18		5	15.11	10	rep	pipe	30		$216,494	$847,477
NW Medford													
BW1A2A	400	0.002	66		158	276.68	119	1	pipe	60		$124,298	
BW1A5	2000	0.008	54		181	226.37	45	1	pipe	36		$355,327	
BW1B1	318	0.004	21		10	11.52	2	rep	pipe	24		$32,579	
BW1B2	434	0.007	18		9	11.52	3	rep	pipe	21		$39,179	
BW1C2	330	0.003	21		9	22.57	14	rep	pipe	30		$41,106	
BW1C3	415	0.003	18		6	22.57	17	rep	pipe	30		$51,694	$644,183
Oak Street													
BW1A6	415	0.006	36		53	172.17	119	3	pipe	36		$178,527	
BW1A7	956	0.012	30		45	52.67	8	rep	pipe	36		$137,086	
BW1A8	1526	0.013	24		26	52.67	27	rep	pipe	36		$218,821	$534,434
Bear Creek West - Columbus													
BW1D1	319	0.006	24		18	65.3	47	3	pipe	24		$98,044	
BW1D2	416	0.006	36		53	65.3	12	1	pipe	21		$37,554	
BW1D6	227	0.004	24		13	16.15	3	rep	pipe	27		$25,533	
BW1E1	1265	0.003	24		13	49.15	36	3	pipe	24		$388,794	
BW1E2	2727	0.010	18		10	13.3	3	rep	pipe	21		$246,178	$796,102
Jackson													
BW1G1	2110	0.011	18		11	39.36	28	rep	pipe	30		$262,832	
BW1H1	1342	0.005	24		16	35.27	19	rep	pipe	36		$192,436	
BW1H2	876	0.007	18		9	19.12	10	rep	pipe	27		$98,532	$553,801
8th Street													
BW1J1	182	0.032	20		25	33.03	8	rep	pipe	24		$18,646	
BW1J2	1002	0.013	20		16	33.03	17	rep	pipe	27		$112,704	$131,350

Drainage Basin: **Bear Creek West**

Table 4-7.1 **Recommended Alternative:** **Diversion after BW1A10 to K7**

West 10th													
BW1K1	635	0.008	42		92	120.05	28	1	pipe	27		$82,434	
BW1K2	224	0.020	36		94	120.05	26	1	pipe	24		$22,949	
BW1K3	396	0.004	42		61	120.05	59	1	pipe	42		$74,975	
BW1K4	988	0.007	36		58	120.05	62	2	pipe	30		$246,140	
BW1K5	844	0.007	30		35	90.4	55	2	pipe	30		$210,266	
BW1K7	1979	0.003	30		24	68.08	44	2	pipe	30		$493,028	$1,129,792
Earhart													
BW1L1	872	0.017	30		54	75.24	21	rep	pipe	36		$125,041	
BW1L1A	1200	0.004	24		14	62.13	48	2	pipe	30		$298,956	
BW1L2	1200	0.006	24		18	42.16	24	rep	pipe	36		$172,074	
BW1L3	3414	0.005	18		7	22.19	15	rep	pipe	30		$425,265	
BW1N1	938	0.006	18		8	19.97	12	rep	pipe	27		$105,506	
BW1R1	345	0.009	18		10	13.11	3	rep	pipe	21		$31,145	$1,157,986
6th Street													
BW1P1	155	0.006	30		32	59.97	28	1	pipe	30		$19,308	
BW1P2	3489	0.010	24		22	29.98	8	rep	pipe	27		$392,441	$411,749
Other structural costs													
										Drainage Basin Total =			$6,206,874

Selected Arrangement Codes: box = box culvert, par = parallel culvert, rep = replacement, 1 or 2 or 3 = number of parallel pipes

Date: 09/17/96 J:\2119\COSTEST\SUMMARY\BWSUM.WB1

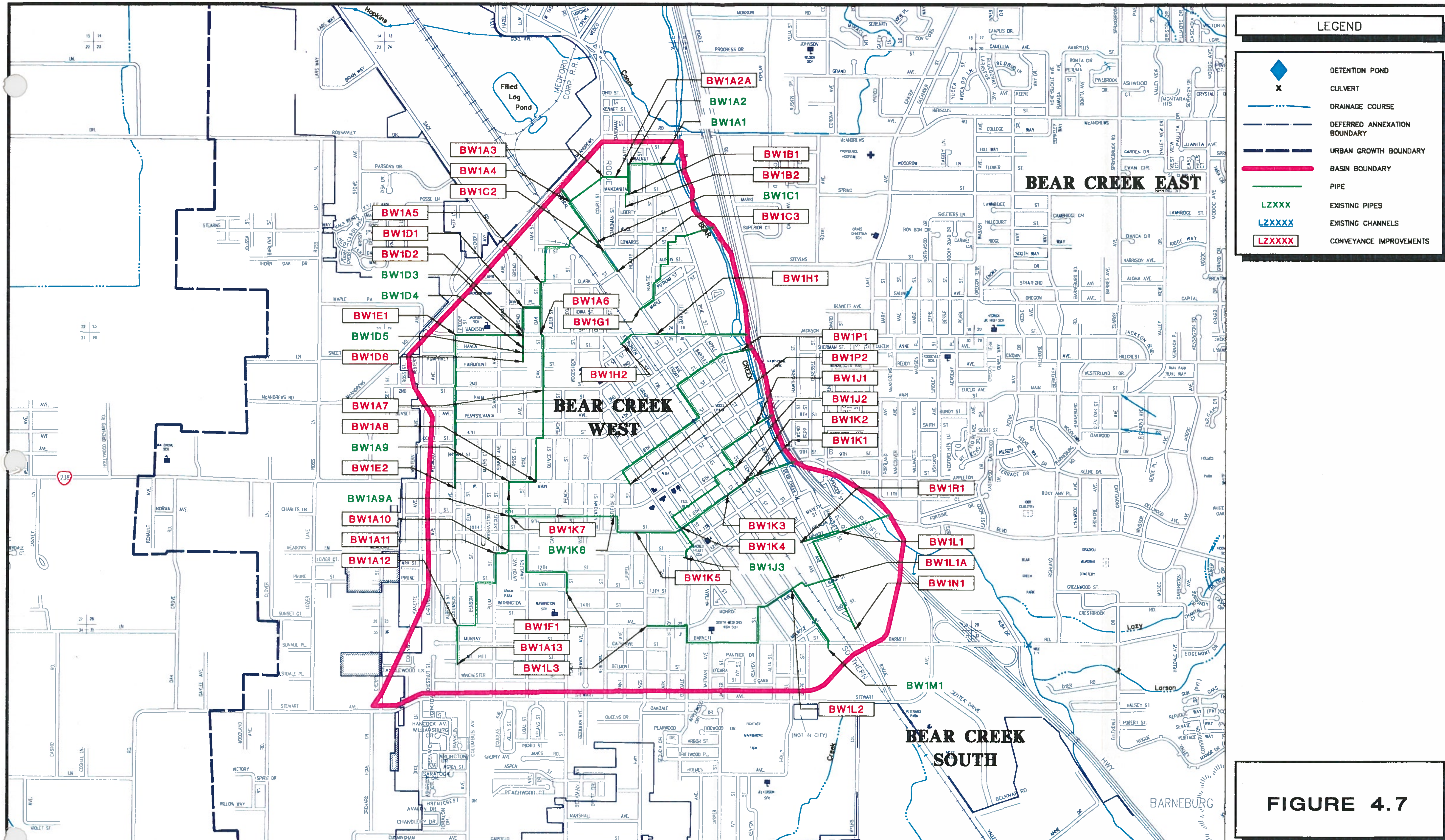
Table 4.7.2 -- Non-CIP Segments

Bear Creek West

Future Condition: Diversion #2

Date: September 96

Element (Tag)	Pipe Length (feet)	Pipe (P) Culvert (C) or Other (O) ?	Depth to Invert (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Percent of Capacity
BW1A1	284	P	8.5	0.003	77		300	309.83	103%
BW1A2	814	P	7.5	0.011	66		346	293.55	85%
BW1A3	62	P	7	0.005	66		238	256.33	108%
BW1A4	733	P	10	0.005	66		238	256.33	108%
BW1A9	537	P	7	0.003		3X2	28	19.17	68%
BW1A9A	453	P	4	0.007	24		18	7.56	42%
BW1C1	285	P	4	0.022	24		34	22.57	66%
BW1D3	66	P	7	0.008	54		178	16.15	9%
BW1D4	265	P	4	0.008	24		21	16.15	77%
BW1D5	60	P	7	0.004	30		25	16.15	65%
BW1J3	2609	P	4	0.008	24		20	19.22	96%
BW1K6	57	P	6	0.049	36		148	90.4	61%
BW1M1	1040	P	3.5	0.007	60		215	19.97	9%



BROWN AND CALDWELL
Portland, Oregon
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CITY OF MEDFORD

North
0 800 1600
Scale in Feet

Drainage Master Plan

BEAR CREEK WEST
DIVERSION, 10TH STREET

Elk Creek

The Elk Creek drainage basin contains 3000 acres on the west side of Medford. The most noticeable feature of the drainage is the lack of slope. From the highest elevation in the south, to the lowest point to the north. The topographic relief is only 100 feet, ranging in elevation from 1400 feet to 1300 feet. The average slope of the conveyance system is 0.7 percent. The lack of relief and the resulting low slopes in the drainage system severely reduce the capacity of the drainage system. In some areas of the basin a discernable drainageway does not exist.

Hopkins Canal cuts across the drainage basin from east to west near Gore Avenue. Several log ponds and numerous wetlands are located throughout the basin. Extension of the Medco haul road could impact a sizeable wetland (4.9 acre) located in the central portion of the drainage basin. Alignment of the extension could be adjusted to limit losses of the existing wetland.

Approximately 80 percent of the area is zoned residential. Industrial zoning accounts for 16 percent of the total. Overall, only about 54 percent of the drainage basin has been developed. Alternative 3, the MedCo Road Diversion, is the recommended alternative. The recommended alternative is shown as Figure 4-8.

RECOMMENDED ALTERNATIVE	
Alternative 3, MedCo Road diversion	**$10,708,000**

The MedCo Road Diversion alternative provides the best opportunities for decreasing flows along the main stem, but would require construction of nearly a mile of 72-inch pipe to convey flows to Bear Creek. The cost of the diversion pipe is estimated as approximately $2.0 million. Opportunities exist for limiting the cost and disruption of this diversion alternative by cooperating with the Oregon Department of Transportation for the planned extension of the MedCo haul road. Under a shared expense scenario, this alternative becomes very attractive. This alternative would minimize traffic disruption and greatly reduce the number and size of pipe upgrades required along the main stem.

Other pipe projects include Beall Lane, Connell Avenue, Ehrman Way, Mace Road, Howard Avenue, Morningside, Lars Way, Stowe Avenue, Highway 99, Berrydale, and a miscellaneous project. These eleven projects range from $24,000 to $2.6 million. The recommended improvements are shown in Table 4-8.1.

Since 1981, the City has required the use of on-site runoff detention for all industrial and commercial development within the basin. On-site detention is provided to limit the peak runoff rates during the design storms to 0.25 cubic feet per second per acre of new or redevelopment. This requirement should be continued. The flat slope of the basin limits the effectiveness of the conveyance system. The existing on-site detention policy and the implementation of the recommended alternative will help ensure that flooding in the basin in minimized.

Physical information on the elements of the drainage system not requiring improvement are shown in Table 4-8.2. The design flows for the open channel segments of the drainage system are shown in Table 4-8.3.

Drainage Basin: Elk Creek

Table 4-8.1 Recommended Alternative: diversion

Element (Tag)	Pipe Length (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Excess Flow (cfs)	Selected Arrangement	Selected Convey	Selected Pipe Diameter (in) or Height (ft)	If Box Culvert Additional Width (ft)	Total Element Cost	Total Project Cost
Beall Lane													
EK1A1	72	0.0029	18		8	20	12	rep	culvert	27		$8,099	
EK1A3	36	0.0028	12		3	20	17	rep	culvert	27		$4,049	
EK1A5	31	0.0065	18		8	20	12	rep	culvert	27		$3,487	
EK1A6	74	0.0034	18		8	20	12	rep	culvert	27		$8,323	$23,958
Connell Avenue													
EK1B1	50	0.0004		10x5	345	716	371		box		11	$70,000	
EK1B3	260	0.0031		8x4	247	685	438	3	pipe	60		$285,452	
EK1B4	1090	0.0046	78		356	673	317	1	pipe	84		$535,558	
EK1B5	1035	0.0060	72		329	581	252	1	pipe	66		$378,773	
EK1B6	165	0.0136	72		495	562	67	1	pipe	30		$32,702	
EK1B7	804	0.0044	72		281	562	281	2	pipe	60		$499,677	$1,802,162
Ehrman Way													
EK1B9	107	0.0093	36		64	281	217	3	pipe	42		$60,669	
EK1B9A	107	0.0093	36		64	281	217	3	pipe	42		$60,669	
EK1K1	106	0.0047	18		8	37	29	rep	culvert	36		$15,200	
EK1K3	50	0.0100	24		16	37	21	rep	culvert	36		$7,170	
EK1K5A	150	0.0033	30		24	31	7	rep	pipe	36		$21,509	
EK1K6	1065	0.0061	18		8	22	14	rep	pipe	27		$119,791	
EK1Z2	80	0.0063	42		65	217	152		box		11	$102,620	
EK1Z2A	80	0.0063	42		65	217	152		box		11	$102,620	
EK1X1	46	0.0109	18		8	9	1	rep	culvert	21		$4,153	$494,400
Mace Road													
EK1C1	1630	0.0017	30		17	42	25	2	pipe	27		$366,683	
EK1C2	62	0.0145	24		16	29	13	rep	culvert	36		$8,891	
EK1C6	84	0.0060	18		8	14	6	rep	culvert	24		$8,606	$384,179

Drainage Basin: **Elk Creek**

Table 4-8.1 **Recommended Alternative:** **diversion**

Howard Avenue													
EK1D1	670	0.0030	24		12	20	8	rep	pipe	30		$83,459	
EK1E3	50	0.0188	18		8	12	4	rep	culvert	24		$5,122	
EK1F3	170	0.0023	18		5	13	8	rep	pipe	27		$19,122	
EK1G1	480	0.0023	48		69	79	10	1	pipe	24		$57,004	
EK1G3	1086	0.0096	24		22	43	21	rep	pipe	36		$155,727	
EK1G4	1044	0.0058	18		8	43	35	rep	pipe	36		$149,705	
EK1H1A	125	0.0050	24		16	61	45	3	pipe	24		$38,418	
EK1H2	793	0.0040	18		7	18	11	rep	pipe	27		$89,196	$597,753
Morningside													
EK1J4	850	0.0052	24		16	31	15	rep	pipe	36		$121,886	
EK1J5	96	0.0042	21		11	31	20	rep	culvert	36		$13,766	$135,652
Lars Way													
EK1M1A	46	0.0102	36		44	105.5	62		box		7	$42,907	
EK1M1B	46	0.0065	36		44	105.5	62		box		7	$42,907	
EK1M1C	46	0.0059	36		44	105.5	62		box		7	$42,907	
EK1M1D	46	0.0048	36		44	105.5	62		box		7	$42,907	
EK1M2	1219	0.0030	60	5.9x3.9, b	143	422	279	2	pipe	60		$759,437	$931,063
Stowe Avenue													
EK1N1	250	0.0118	30		45	331	286	3	pipe	42		$141,750	
EK1N11B	130	0.0100	30		41	66	25	rep	pipe	36		$18,641	
EK1N12	250	0.0045	54		132	201	69	1	pipe	48		$53,207	
EK1N13A	70	0.0100	18		8	66	58		box		14	$95,305	
EK1N13B	70	0.0100	18		8	66	58		box		14	$95,305	
EK1N15	70	0.0100	24		16	201	185		box		25	$157,903	
EK1N17	70	0.0100	30		28	103	75		box		9	$73,500	
EK1N19	160	0.0100	30		41	103	62	2	pipe	30		$39,861	
EK1N2A	60	0.0533	36		154	199	45	1	pipe	18		$5,030	
EK1N3	265	0.0022	42		47	332	285	3	pipe	60		$247,643	
EK1N4	911	0.0058	36		51	332	281	3	pipe	48		$581,660	
EK1N6	880	0.0097	30		40	332	292	3	pipe	42		$498,960	
EK1N9	70	0.0100	36		44	258	214		box		17	$119,805	
EK1P1	899	0.0074	36		57	68	11	1	pipe	21		$81,157	
EK1P2	60	0.0110	30		43	72	29	1	pipe	27		$6,749	
EK1P3	685	0.0027	36		35	72	37	2	pipe	30		$170,654	
EK1P4	900	0.0049	30		29	61	32	2	pipe	27		$202,463	$2,589,592

Drainage Basin: Elk Creek

Table 4-8.1 Recommended Alternative: diversion

Highway 99													
EK1S1	96	0.0521		6x3	94	550	456		box		30	$261,408	
EK1S3	1864	0.0032	18		6	25	19	rep	pipe	36		$267,289	
EK1S4	207	0.0097	24		22	25	3	rep	pipe	27		$23,283	
EK1S5	550	0.0036	18		6	25	19	rep	pipe	36		$78,867	$630,847
Berrydale													
EK1T3	435	0.0012	18		4	28	24	3	pipe	27		$146,786	$146,786
Elk Miscellaneous													
EK1V1	2600	0.0071	30		35	118	83	3	pipe	30		$971,607	$971,607
EKMEDCO	5120	0.0039	72		265	250	N/A				estimated	$2,000,000	$2,000,000
										Drainage Basin Total =			$10,708,000

Selected Arrangement Codes: box = box culvert, par = parallel culvert, rep = replacement, 1 or 2 or 3 = number of parallel pipes

Date: 09/17/96 J:\2119\COSTEST\SUMMARY\ELKSUM.WB1

Table 4.8.2 -- Non-CIP Segments

Elk Creek
Future Condition: Diversion
Date: September 96

Element (Tag)	Pipe Length (feet)	Pipe (P) Culvert (C) or Other (O) ?	Depth to Invert (feet)	Slope	Existing Pipe Diameter (inches)	Existing Box Culvert (feet)	Existing Flow Capacity (cfs)	Modeled Flow (cfs)	Percent of Capacity
EK1C4	84	C	4	0.0064	24		16	15	94%
EK1E1	760	P	4.5	0.0044	30		27	12	44%
EK1E2	350	P	4	0.0069	24		19	12	63%
EK1F1	35	C	6	0.0143	48		91	13	14%
EK1F2	10	C	4	0.0030	24		16	13	81%
EK1G2	1167	P	5.5	0.0050	42		71	61	86%
EK1H1	2807	P	4	0.0055	24		17	18	106%
EK1J1	120	P	5.5	0.0017	42		42	31	74%
EK1J2	517	P	5	0.0040	36		42	31	74%
EK1J3	441	P	4.5	0.0072	30		35	31	89%
EK1K5	180	P	4.5	0.0028	30		22	22	100%
EK1L1	1236	P	4	0.0049	24		16	14	88%
EK1L2	102	P	3.75	0.0263	21		26	14	54%
EK1L3	702	P	4	0.0071	24		19	14	74%
EK1M3	1200	P	6	0.0025	48		72	36	50%
EK1N11A	130	P	5	0.0100	36		67	66	99%
EK1N2B	60	P	4.5	0.0027	30		21	21	100%
EK1N5A	355	P	4	0.0114	24		24	24	100%
EK1N5B	355	P	4	0.0114		6x3	3159	110	3%
EK1Q1	965	P	3.75	0.0062	21		12	8	67%
EK1Q2	384	P	3.5	0.0117	18		11	8	73%
EK1R1	246	P	4	0.0081	24		20	10	50%
EK1R2	825	P	3.5	0.0091	18		10	10	100%
EK1T2	1199	P	4.5	0.0068	30		34	28	82%
EK1U1	550	P	4.5	0.0040	30		26	20	77%
EK1U2	900	P	4	0.0108	24		24	20	83%
EK1W1	282	P	5	0.0018	18		4	2	58%
EK1Y1	67	C	4	0.0075	24		16	6	38%

Table 4-8.3 Elk Creek
Open Channel Flows

Element (Tag)	Channel Length	Slope	Controlling Storm	Modeled Flows (cfs)
EK1A2	280	0.0012	10sz	20.26
EK1A4	1300	0.0022	10sz	20.26
EK1B2	280	0.0004	25sz	685.56
EK1B8	300	0.0087	25sz	562.45
EK1C3	70	0.0057	10sz	29.09
EK1C5	800	0.0056	10sz	13.74
EK1K1A	70	0.0071	10sz	36.62
EK1K2	580	0.0026	10sz	36.62
EK1K4	550	0.0018	10sz	36.62
EK1N10	800	0.0100	25sz	201.29
EK1N14	1300	0.0100	25sz	201.29
EK1N16	1700	0.0100	10sz	102.85
EK1N18	700	0.0100	10sz	102.85
EK1N20	3000	0.0100	10wz	56.19
EK1N7	600	0.0100	10sz	85.61
EK1N8	700	0.0100	25sz	258.47
EK1P5	1000	0.0045	10sz	16.44
EK1S2	380	0.0053	10sz	25.15
EK1T1	385	0.0054	10sz	28.26
EK1Z1	200	0.0050	25sz	458.68
EK1Z3	2500	0.0043	25sz	445.58

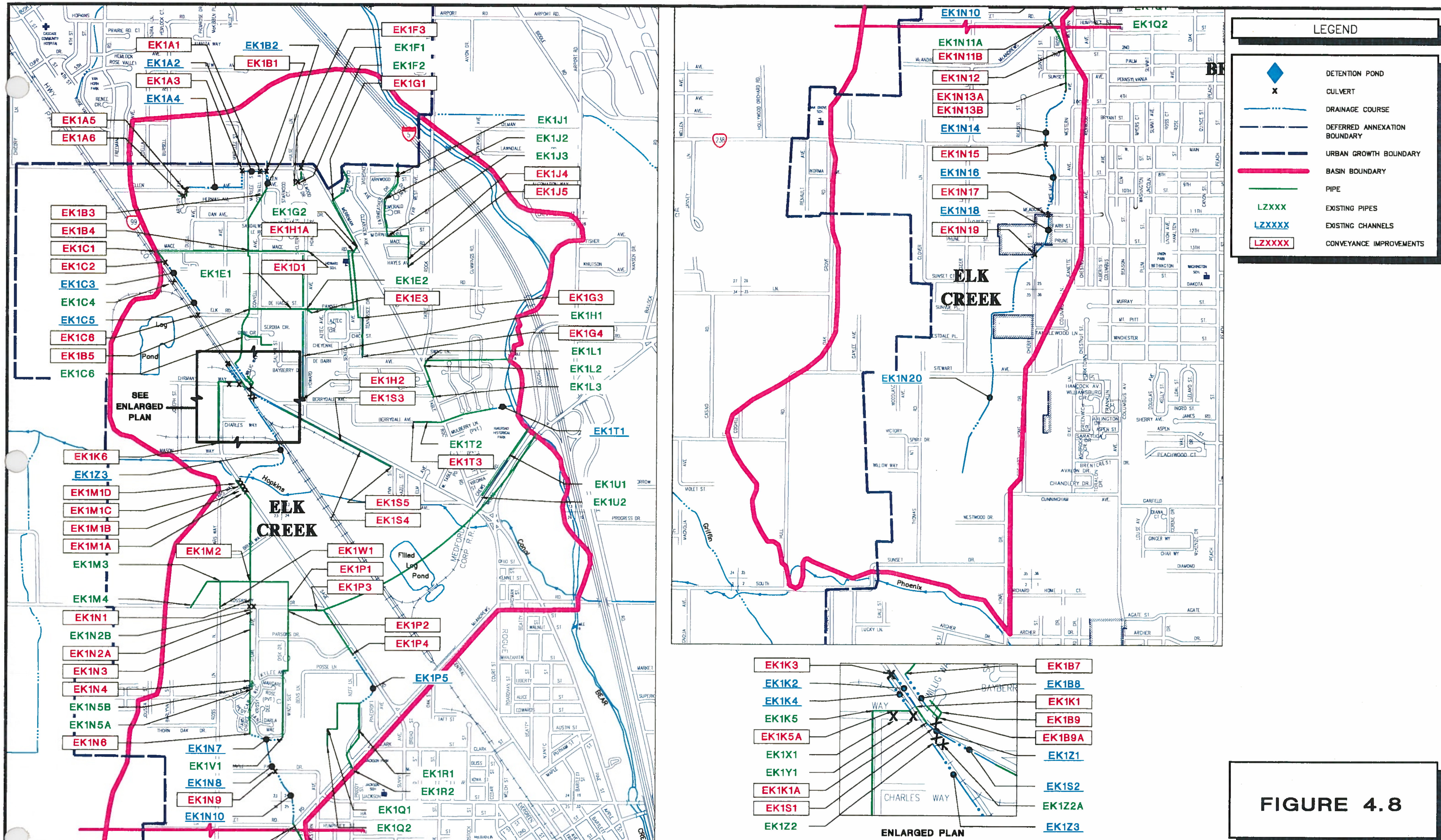

FIGURE 4.8

BROWN AND CALDWELL
Portland, Oregon
(503) 244-7005

CITY OF MEDFORD

North
0 800 1600
Scale in Feet

Drainage Master Plan

ELK CREEK
DIVERSION, MEDFORD ROAD

Summary

The recommended alternative for each drainage basin is shown in Table 4-9.

Table 4-9. Basin Alternative Summary

Drainage Basin	Selected Alternative	Estimated Capital Cost
Midway Drainage	Alternative 1 - Conveyance	$2,732,000
Lone Pine Creek	Alternative 2 - 12.5 a.f. detention	$2,605,000
Bear Creek East	Alternative 1 - Conveyance	$5,302,000
Lazy Creek	Alternative 2 - 30 a.f. detention	$3,728,000
Larson Creek	Alternative 1 - Conveyance	$1,652,000
Crooked Creek/Bear Creek South	Alternative 1 - Conveyance	$2,196,000
Bear Creek West	Alternative 3 - Diversion #2	$6,207,000
Elk Creek	Alternative 3 - Diversion	$10,708,000
Total All Projects		$35,130,000

Note: Cost includes construction, engineering, right-of-way, and contingency in 1995 dollars. (*ENR* CCI index 5433).

Table 5-2. Priority Ranking of Stormwater Facility Improvements

Project Name	Drainage Basin	Total Project Cost	Average Excess Flow (cfs)	Flood Relief	Impact on Neighborhood	Frequency of Problems	Environmental and Regulatory Sensitivity	Total Score
Lazy Creek at Highland Drive	LZ	$141,610	573	4	3	3	4	14
Oak Street	BCW	$534,434	51	2	4	4	4	14
Peach Street	CC/BCS	$172,966	4	1	4	4	4	13
Other structural costs - pond	LZ	$2,000,000	N/A	4	3	2	4	13
North Fork	LA	$945,871	100	2	4	4	3	13
Earhart	BCW	$1,157,986	21	1	4	4	4	13
King Center Upgrade	MID	$1,629,564	247	3	4	3	3	13
Berrydale	ELK	$146,786	24	1	4	4	4	13
Lone Pine Central	LP	$650,114	165	2	4	4	2	12
Other structural costs - pond	LP	$438,000	N/A	4	2	2	4	12
Elk Miscellaneous	ELK	$971,607	83	2	3	3	4	12
Sunrise	BCE	$296,576	68	2	3	3	4	12
Howard Avenue	ELK	$597,753	18	1	3	3	4	11
Brookhurst	BCE	$962,013	113	2	3	2	4	11
Delta Waters Upgrade	MID	$424,581	53	1	3	3	4	11
Crooked near Stewart Avenue	CC/BCS	$182,490	224	3	2	2	4	11
Washington	BCW	$847,477	31	1	3	3	4	11
Connell Avenue	ELK	$1,802,162	288	3	2	2	4	11
Eagle Trace	LZ	$65,395	19	1	3	2	4	11
Lazy Creek at Murphy Road	LZ	$62,213	285	3	2	2	4	11
6th Street	BCW	$411,749	18	1	3	3	4	11
Lazy Creek at Crestbrook Road	LZ	$168,805	602	4	2	1	4	11
Lazy Creek at Burgundy	LZ	$204,208	637	4	2	1	4	11
North Phoenix	LZ	$385,253	231	3	2	2	4	11
Skycrest	LZ	$73,850	213	3	2	2	4	11
Lazy Creek at Siskyou Blvd.	LZ	$252,000	502	4	3	1	3	11
Oregon Avenue	BCE	$245,830	11	1	3	3	4	11
Larson Central	LA	$469,277	471	4	2	2	3	11
Lazy Creek at Ellendale Drive	LZ	$174,195	616	4	2	1	4	11
Middle Fork	LP	$316,639	92	2	2	3	3	10
Highway 99	ELK	$630,847	124	2	2	2	4	10
Lazy Creek at Oak Drive	LZ	$142,854	254	3	1	2	4	10
NW Medford	BCW	$644,183	53	2	2	2	4	10
Crooked near Dove Lane	CC/BCS	$201,984	144	2	2	2	4	10
EKMEDCO - diversion section	ELK	$2,000,000	N/A	4	2	1	3	10
Stowe Avenue	ELK	$2,589,592	120	2	4	2	2	10
Ehrman Way	ELK	$494,400	90	2	2	2	4	10
Blackoak	LA	$236,396	474	4	1	1	4	10

Funding

City of Medford Ordinance No. 4940 created a utility to fund establishment, and operation and maintenance of the storm drainage system. The utility eliminated the need for other resources, such as the General Fund or state Gas Tax funds, to be used for the storm drainage system. Revenues generated from the utility will be used exclusively for the storm drainage system.

The utility assigns costs based on the impervious area of a facility. This approach ensures that those contributing the most stormwater runoff will pay the appropriate higher costs. Unit of measurement is based on an equivalent residual unit (ERU) equal to 3,000 square feet of impervious surface. The 1996 monthly charges per ERU are $2.95.

CHAPTER 5

IMPLEMENTATION PLAN

This chapter summarizes the plan for implementing the recommended improvements to the Medford drainage system. Appendix C presents alternatives developed to address the deficiencies defined by the modeling for each drainage basin. The alternatives evaluation process defined in Appendix C was used to select a preferred or recommended alternative for each drainage basin. The recommended plan is described in Chapter 4 by basin. Within each recommended basin plan, the improvements required to address the deficiencies have been grouped into projects. Each project may include several improvements that have been grouped together based upon cost and location to define a single construction project. The purpose of this chapter is to develop an implementation plan that defines a priority ranking of all projects throughout the city.

It is unlikely that current funding levels will allow implementation of all the projects defined by this DMP. A priority ranking of the projects is required to determine the order in which projects should be completed. The priority ranking process ranks all projects based upon the benefits derived from the project. In this way, the City will be able to focus its resources on those projects which provide the greatest benefit.

Priority Ranking Process

Four criteria were used to evaluate the priority ranking of the projects: flood/flow relief, flooding impact on the neighborhood, frequency of problems, and environmental and regulatory sensitivity. The criteria are defined as follows:

- **Flood/Flow Relief.** The average excess flow rate during a design storm was calculated for each group. The excess flow rate for each deficient area was determined and all values within a group averaged. Excess flow rate is defined as flow that cannot be contained completely within the defined conveyance system (open or closed channel). The average excess flow is calculated in cubic feet per second (cfs). The impact of the flooding is not considered.

- **Impact on Neighborhood.** The land use and topography of a neighborhood will define the level of impact of a flooding event. This was examined for both current and build-out conditions. The collective experience of several City personnel was used to make this determination. An in-depth analysis of direct economic costs associated with flooding was beyond the scope of this study.

- **Frequency of Problems.** City personnel are well acquainted with many of the problem areas defined by the modeling. Their experience was used to identify the areas that have historically had reoccurring flooding problems.

- **Environmental/Regulatory Sensitivity.** Regulatory permits may be difficult to acquire for projects located in or near wetlands or natural streams. Projects with these sensitivities should only be implemented if the project provides substantial overall benefit to the City and the watershed.

The scoring used for each criterion is shown in Table 5-1.

Table 5-1. Scoring for Priority Ranking

Criteria	Numeric Score			
	1	2	3	4
Flood Relief, cfs	< 50	50 to 200	> 200 to 400	> 400
Impact on Neighborhood	none	low	moderate	high
Frequency of Problems	none	seldom	moderate	frequent
Environmental and Regulatory Sensitivity	high	moderate	low	none

Priority Ranking Summary

The results of the priority ranking process are shown in Table 5-2. The City may use this table and the known funding available for a given year to determine the projects to be included in the annual capital improvement program (CIP). This priority ranking provides a guideline to the City on the order in which projects should be implemented. However, a number of other factors must be considered in this decision making process that cannot be accounted for by this study. City staff will make the final decision on when to fund each project.

Wetland Mitigation

Future development and storm drainage system improvements will impact the existing wetlands within the Medford area. Wetland regulations were written by federal and state governments to protect these valuable natural resources. In general, wetlands lost or degraded by development and construction must be mitigated. A Wetlands Mitigation Concept Plan (June, 1996) has been developed by the City to help offset the impact of future wetland losses by planning for their mitigation ahead of time. The areas identified by the plan should be acquired by the City as soon as possible to prevent their loss to development.

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REFERENCES

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